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APPLE LEAF-ROLLERS OF THE GENERA AMORBIA, ARCHIPS, EULIA, PANDEMIS AND PERONEA

By S. W. FROST[1]

ABSTRACT

This is an introductory paper to a more complete and detailed study of economic leaf-rollers. It summarizes numerous scattered life-history studies, comparing them as to range of food plants, number of broods, manner of hibernation and other minor habits. It contains many original notes by the writer.

In studying the life-histories of several little known leaf-rollers especially of the genera Amorbia and Eulia, the writer became engrossed in the general subject of leaf-rollers. New life-history studies and a review of the habits of well known species have revealed some interesting comparisons, and have opened up new problems of control. The present paper is confined to five genera containing the more important leaf-rolling species attacking apple.

The group "Leaf-rollers" is an artificial one, used for convenience in speaking popularly of insects with certain common habits. The larvae of these species roll a single leaf, or gather several leaves together as a convenient shelter in which or from which they feed. This habit occurs in many of the leaf-feeding Lepidoptera. Felt (1905–06) lists individuals of nineteen genera as leaf-rollers of park and woodland trees. There is no dividing line between these species and the so called bud-moths and fruit worms, although we are prone to call some leaf-rollers, and others bud-moths. Sanders and Dustan (1919), as a matter of fact, include the leaf-rollers under bud-moths. It is useless to attempt to formulate systematic or biological limits for such groups. It is for this reason that the species are discussed by genera rather than by habits.

[1]Published by permission of the Director of the Agricultural Experiment Station as a part of Project No. 636. Contribution from the Department of Zoology and Entomology, The Pennsylvania State College, Technical Paper No. 406.

A Scientific Classification of Leaf-Rollers

The economic species of leaf-rollers attacking apple in North America fall in five genera; Amorbia, Archips, Eulia, Pandemis and Peronea. These are summarized in the following table. Archips is well known to all Entomologists; Eulia and Peronea contain species familiar to some, while Amorbia, and certain species of Peronea are as yet little known.

A Summary of the Leaf-Rollers Injurious to Apple

Species	Host plants, other than apple
Archips argyrospila Wlk.[1]	44 food plants have been listed, cherry and small berries most important.
Archips franciscana Walsh	Western species.
Archips parallela Rob.	Cranberry, pitcher-plant.
Archips rosaceana Harris	21 food plants have been listed, members of the rose family are most important.
Archips rosana Linn	Raspberry, rose, hawthorn, hazel, currant, gooseberry, elm, willow, linden, aspen.
Archips purpurana Clem.	Blackberry and geranium.
Eulia velutinana Wlk.	52 food plants have been listed, truck crops and small fruits most important.
Eulia quadrifasciana Fern.	From apple only.
Eulia mariana Fern.	Vaccinium, from apple (writer).
Amorbia humerosana Clem.[2]	Huckleberry, pine, poison ivy, spice bush, *Linderia benzoin*.
Pandemis limatata Rob.	Oak, Solidago, sassafras, birch, rose, hazel, from apple (writer).
Pandemis pyrausana Kearf.	Western species.
Peronea logiana Schiff.[3]	Wild cherry, viburnum.
Peronea maculidorsana Clem.	Willow.
Peronea maxima B. B.	From Canada.
Peronea undesc. species	From apple only (writer).
Peronea minuta Rob.	Huckleberry, cranberry, pear, plum, whortleberry, wild rose.

[1]The following exotic species have been recorded from apple: *Archips ribeana* Hubn., *rheediella* Clerck, *achatana* Fab., *podana* Sc., and *leparana* Schiff, from Europe, *A. sinapina* Ball and *A. ingentana* Japan.

[2]*Amorbia emigratella* Busck was described from Mexico, and has numerous hosts in the Hawaiian Islands.

[3]*Peronea maxima* from Br. Columbia and *P. agrioma* Meyrick from India. Both attack apple.

A Biological Classification of Leaf-Rollers

Aside from their systematic classification, the leaf-rollers of apple can further be divided for the convenience of the economic entomologist into groups according to their habits: (1) hibernating as eggs, larvae, pupae or adults, (2) one, two or three brooded, (3) defoliators of trees,

or simply feeders of fruit and foliage, causing no defoliation, (4) spinning an abundance of silk, often living in webs, or spinning but a scant amount of silk, (5) with one or with several distinct color forms. These habits are best summarized in tabular form.

TABLE SHOWING THE OUTSTANDING HABITS OF THE LEAF-ROLLERS OF THE GENERA AMORBIA, ARCHIPS, EULIA, PANDEMIS AND PERONEA*

Habit	Amorbia	Archips	Eulia	Pandemis	Peronea
Method of hibernating	pupae	eggs[1]	pupae	?	adults
Number of broods	1	1 or 2	usually 3[3]	?	3
Amount of silk spun	scant	abundant	scant	?	scant
Defoliation of trees	sometimes[2]	frequently	never	?	never
Number of color forms	1	sometimes dimorphic	usually dimorphic	1	several to 40

*Economic species other than those feeding on apple are considered here in order to complete the table.

[1]As larvae in Canada.

[2]*Amorbia emigratella* Busck reported as defoliating trees in Hawaiian Islands.

[3]Hartzell (1919) gives one brood for *Eulia pinatubana*.

Considerable variation exists in the number of broods and method of hibernation in the genus Archips. This variation is due chiefly to latitude. In the United States, apparently, all the species of this genus hibernate as eggs, while in Canada, both in British Columbia and Nova Scotia, *Archips rosaceana* hibernates as partially grown larvae. It is interesting to note further that there is but one brood for both *A. argyrospila* and *A. rosaceana* in Canada. A few records for these species as well as some rarer species are given in the following table.

LIFE HISTORY RECORDS OF ECONOMIC SPECIES OF ARCHIPS

Species	Method of Hibernation	Locality	Authority
Archips rosaceana Harris	Eggs	New York	Herrick (1912)
	Eggs	S. Dakota	Severin (1919)
	Larvae	Br. Columbia	Venabeles (1924)
	Larvae	Nova Scotia	Sanders & Dustan (1919)
Archips argyrospila Walk.	Eggs	New York	Herrick (1912)
	Eggs	Oregon	Fulton (1921)
	Eggs	Br. Columbia	Venabeles (1924)
Archips rosana Linn.	Eggs	Canada	Gibson (1924)
Archips franciscana Walsh	Probably as full grown larvae	California	Penny (1921)
Archips cerasivorana Fitch.	Eggs	New York	Herrick (1912)
	Eggs	Canada	Baird (1918)
Archips obsoletana Walk.	Probably as eggs	New York	Slingerland (1901)

Species	Number of broods	Locality	Authority
Archips rosaceana Harris.	2	New York	Herrick (1912)
	2	S. Dakota	Severin (1919)
	1	Br. Columbia	Venabeles (1924)
	1	Nova Scotia	Sanders & Dustan (1919)
Archips argyrospila Walk.	2	Mass.	Packard (1885)
	1	New York	Herrick (1912)
	1	Colorado	Gillette (1892)
	1	Missouri	Stedman (1906)
	1	New Mexico	Gill (1913)
	1	Br. Columbia	Venabeles (1924)
Archips rosana Linn.	apparently 1	Canada	Gibson (1924)
Archips franciscana Walsh	?		
Archips cerasivorana Fitch.	1	New York	Herrick (1912)
Archips obsoletana Walk.	2 or 3	New York	Slingerland (1901)

The variety of color forms appears especially in the species of Peronea. The European *Peronea hastiana* Linn. is a remarkably variable species having over forty described color varieties. The writer has reared a species that feeds on apple which runs close to *hastiana*, but which Mr. August Busck of the National Museum pronounces a new species. Lack of sufficient material has prevented him from describing it. Four distinct color forms were reared, varying from brown to gray. The hibernating adults are dark brown in color with a straw colored head and thorax. *Peronea minuta* Rob., another well known feeder of apple, has two distinct color varieties: an orange form and a gray form. Riley (1872) bred the slate colored form, and supposing it to be an undescribed species, gave it a new name, *Tortrix cinderella*. It was later discovered that the slate colored moths were the hibernating forms of *P. minuta*.

A Discussion of the Genera and Species

Amorbia. We know very little concerning the habits of the species of Amorbia. It is a small genus represented by a single species, *A. humerosana* Clem.,[2] a general feeder in the East, and *A cuneana* Clem., a feeder of bearberry, in the West. To this can be added *A. emigratella*, a species described by Busck (1909) from Mexico, and later introduced into the Hawaiian Islands. In the latter locality it is reported as often being so numerous as to defoliate trees, and sometimes attacks the fruit as well.

Archips. The genus Archips is a comparatively large one containing approximately twenty-five North American species. To this genus

[2]The Dusky Leaf-roller, Bull. 205, Pennsylvania State College, 1926. *A. humerosana* Clem.

belong the well known Fruit-tree Leaf-roller (*A. argyrospila* Wlk.), the Oblique-banded Leaf-roller (*A. rosaceana* Harris), the Obsolete-banded Strawberry Leaf-roller (*A. obsoletana* Walk.), the Ugly-nest Cherry-tree Leaf-roller (*A. cerasivorana* Fitch), and the Blackberry Leaf-roller, *A. purpurana* Clem., together with other species of lesser economic importance. Some are general feeders as *A. argyrospila* Walk., which has been recorded from forty-four different food plants, while others are restricted in their food habits. Among the plants attacked by other species of leaf-rollers are sorbus, box-elder, balsam, hickory and oak. A number of species remain with food plants unknown. In our latitude, all the species attacking apple have one or two broods a season, and hibernate as eggs. The egg stage naturally occupies the greater part of the year, and has a harder covering than the species of leaf-rollers which lay eggs during the summer. The larvae of the species on apple are feeders of the fruit and foliage during the early and middle part of the summer as contrasted with certain species of Eulia which feed late in the fall. These species are thus easily controlled by dormant applications of oil emulsions or miscible oils. We will note later that other species of leaf-rollers demand different means of control.

EULIA. The genus Eulia contains about eleven species of economic importance in North America that feed on oaks, pine and walnut. *E. velutinana* Wlk. has been recorded from fifty-two host plants. The life-histories of *Eulia pinatubana*, *E. velutinana* and *E. quadrifasciana* have been studied in some detail. The habits of the genus seem quite uniform. As far as known, all the species hibernate in this latitude as pupae. Hartzell (1919) records a single brood for *E. pinatubana*, but all other species apparently have three broods. The species that feed on apple, namely *E. velutinana* Wlk., *E. quadrifasciana* Fern., and *E. mariana*, are late feeders, sometimes continuing their attacks on the fruit late into October, and even until the first of November.

PANDEMIS. This is another small genus. There are probably five North American species. Two of these are known to attack apple. *P. limatata* Rob. is a general feeder which the writer recorded from apple for the first time. *P. pyrausana* Kearf. is a western species also occurring on apple. Our knowledge of the habits of this genus is limited to the few records of food plants.

PERONEA. Barnes and McDunnough (1917) list thirty-five species of Peronea and numerous varieties as occurring in North America. The life-histories of a few of these species have been studied in detail, notably *P. minuta* and *P. hastiana*. Other species occur on birch, hemlock,

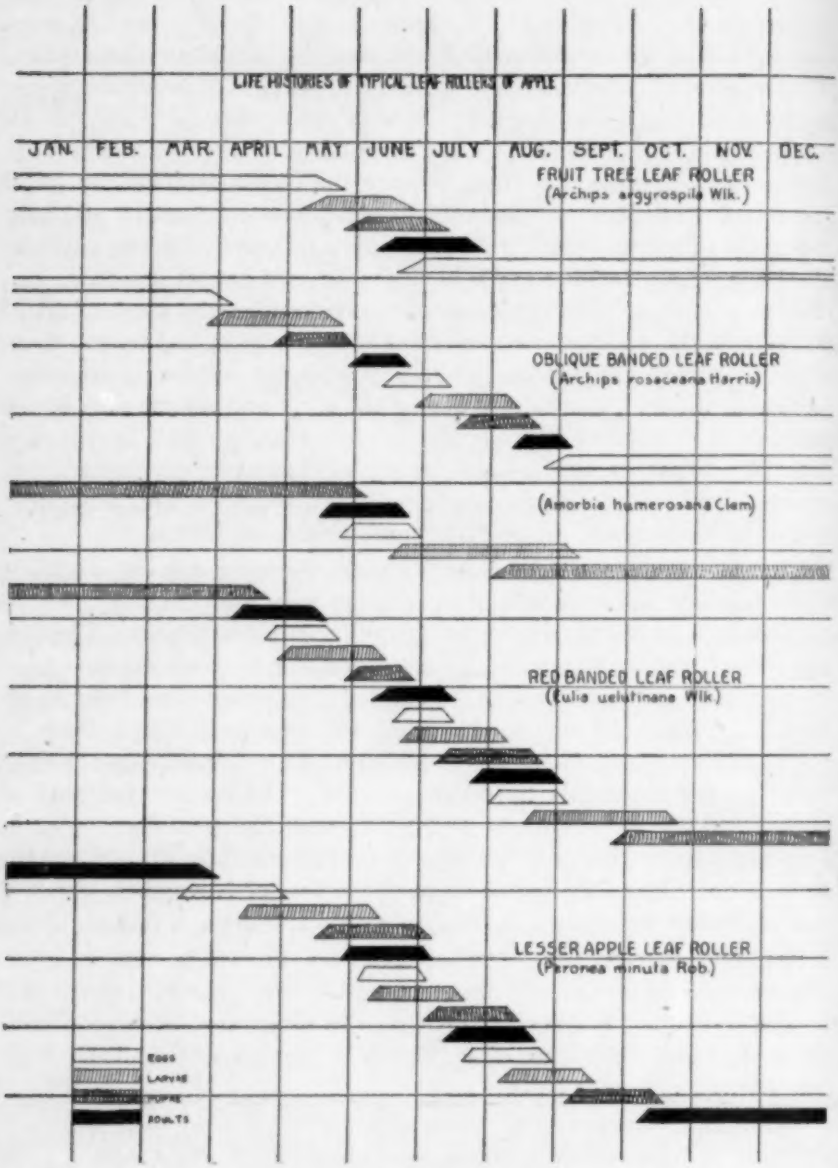

FIG. 48.—Life-history chart.

willow, pear, plum, cherry, crataegus, viburnum, rose, cranberry, strawberry, huckleberry, whortleberry, toad-flax and St. John's wort. The species from crataegus, namely *P. nivisellana* Walsh., would, no doubt, also attack apple. What little we know concerning these species leads us to believe that there are three broods a year, and that the species hibernate as adults.

Typical Life-Histories of Leaf-Rollers

An attempt has been made to summarize in the preceding chart typical life-histories of leaf-rollers of apple, showing their manner of hibernating, comparative length of egg, larvae, pupal and adult stages, and the number of generations. It is difficult to represent, on a chart, such details as periods of egg laying, periods of egg hatching and periods when eggs are simply in a dormant stage. It is remarkable, however, to note the great diversities in habits necessitating widely different control measures.

THE LIFE HISTORY AND CONTROL OF THE CRANBERRY WEEVIL, *ANTHONOMUS MUSCULUS* SAY (COLEOPTERA: CURCULIONIDAE)[1]

By Donald Sewall Lacroix

Abstract

The Cranberry Weevil occurs sporadically on Massachusetts bogs, often causing considerable loss to the cranberry crop before its presence is suspected. Taxonomically, the true cranberry weevil is *Anthonomus musculus* Say, not *A. suturalis* LeConte, as it has been referred to in the past. But one generation a year occurs in Massachusetts. Both larvae and adults are of economic importance. Control measures carried out experimentally resulted in the adoption of a mixture of Bordeaux, calcium arsenate, lime, and fish-oil soap. This proved efficient when applied commercially. The Bordeaux and soap tend to spread the mixture evenly over the waxy cuticle of the cranberry leaf and fruit and to make it stick under severe conditions. The addition of lime safeguards the use of the arsenate and soap in combination, so that there is no danger of foliage injury.

Introduction

The cranberry industry of Southeastern Massachusetts suffers considerable loss through the activities of insects. Many of these appear every year, and are combated more or less successfully by the application of sprays or by the timely flooding of the bogs. Others among the hosts of insect pests occur spasmodically at unexpected intervals

[1]The observations reported in this paper were made in research conducted by the Massachusetts Agricultural Experiment Station.

and, although they may do but little damage in some years, they occasionally appear in such numbers as to cause much anxiety among some growers.

The Cranberry Weevil, *Anthonomus musculus* Say, is one of the latter class. So far as we know, it has never devastated great areas of cranberry bog in Massachusetts, but it becomes abundant here and there at intervals, causing much loss on individual bogs. This weevil's activities are rendered more acute because of its minute size and "underhanded" methods of procedure. A serious infestation is not suspected by the average grower until the crop is well on the way to ruin. The bloom is observed to disappear rather rapidly in early summer and little or no fruit is found. The bog owner often endeavors to explain the loss by saying that the blossoms did not set well, or that a late frost killed them.

A thorough search through the literature has failed to disclose any records of a detailed study of the life history of this insect, either on the cranberry or elsewhere. Likewise, no methods of control seem to have been attempted, either experimentally or otherwise. Then too, the insect has been confused with several other similar species in many instances, as will be indicated below. It seems advisable, in view of the above mentioned facts, to bring together all available information and couple with this detailed observations made during the past two seasons.

The work presented in this paper was carried out under the direction of Dr. H. J. Franklin. To Mr. H. B. Scammell the writer is greatly indebted for his efforts in attempting to locate specimens collected by other workers on this insect, and for observations on the activities of the insect in New Jersey.

The writer would take this opportunity to express his appreciation to Dr. H. T. Fernald for the instruction and helpful criticism extended in connection with this and other work.

Historical

Thomas Say (1)[2] described *Anthonomus musculus* in 1831 from Indiana. Records of this insect next occur in literature in 1885 when Riley (2) stated that the weevil had became a serious pest of the strawberry during 1884 in several eastern states. Later, Dietz, who was a specialist on the Anthonomi, indicated (3) that the weevil which Riley thought was *A. musculus* was really *A. signatus* Say, the true strawberry weevil.

Packard (4) recorded for the first time the activities of a cranberry *Anthonomus* in Massachusetts and stated that the species involved was

[2]Numbers in parenthesis refer to Literature Cited.

A. suturalis LeConte. Lugger (5) mentioned *A. suturalis* as a cranberry feeder. Hardenberg (6), who carried on some investigations of cranberry insects in Wisconsin, again recorded *suturalis* as being destructive to the cranberry. Franklin (7) applied the same name to a cranberry weevil found in abundance in Massachusetts in 1914. The writer found a cranberry weevil on the Cape Cod bogs during the summer of 1924 and was unable to make the species fit the description of *suturalis*. Specimens were sent to Mr. H. C. Fall and Prof. Blatchley for identification, and both agreed that the species was *musculus*. The writer has been unable to locate either Packard's specimens or those studied by Hardenberg, but an examination of Franklin's material revealed the fact that the weevil recorded by him as *suturalis* is identical with *musculus*. Hardenberg's descriptions are rather vauge, but the meager report on the life history of his weevil leads the writer to suspect that his weevil was also *musculus*. In all probability, then, the cranberry weevil of literature has been *Anthonomus musculus* Say instead of *Anthonomus suturalis* LeConte.

Distribution and Food Plants

Anthonomus musculus is a native of North America, and is known to occur from Ontario and New England west to the Rocky Mountains and south to Florida.

It has been found on huckleberry, *Gaylussacia resinosa* Torr. and Gray, and black chokeberry, *Pyrus melanocarpa* Willd. Mr. H. B. Scammell, formerly of the United States Bureau of Entomology, informs me that he took this insect on the cultivated blueberry, *Vaccinium corymbosum* L., at Toms River, New Jersey, during the summer of 1924. As far as can be determined, this paper records *musculus* as a cranberry pest for the first time.

Description

Egg.—Oblong-ovoid, 0.4 to 0.5 mm. long and 0.29 to 0.32 mm. wide; pale lemon-yellow to almost white in color; glistening; viscid; smooth (no sculpturing).

Larva.—Full grown larva yellowish-white; a cylindrical, footless grub, 2.5 to 3 mm. in length; head pale yellow, margins of mandibles brown to black; body strongly curved, so that anal segment and head are closely approximated.

Pupa libera.—2 to 2.5 mm. long, 1 to 1.4 mm. wide; naked, stout, yellowish to white in color; eyes showing as black spots after a few days; legs, beak and wing pads folded tightly against body, the wing pads covering in part the folded legs; beak lying along under side; several spines on head and abdomen; last abdominal segment prolonged into a process bearing two stout spines.

ADULT.—1.5 to 2 mm. long, beak and head of old specimens black, elytra dark red, legs dark. Freshly emerged specimens much lighter in color, beak and head brown, elytra golden-brown. Older individuals may be entirely black. A few white scales scattered over the back give appearance of transverse bands of gray; scutellum covered with white pubescence.

SIMILAR SPECIES

As already indicated, *musculus* has been confused with *suturalis* and also with *signatus*. Hamilton (8) gives a very interesting discussion of *musculus* and *signatus* (the strawberry weevil). He says that the true *musculus* is not very common (in Pennsylvania) and is usually found on huckleberry blossoms; a thorough search through strawberry plantations during several periods of the season disclosed a total absence of *musculus* on that plant.

Dietz (3) says, in writing on *musculus* versus *signatus*, "Aside from the difference in length of the second joint of the funicle which is always evident in fresh and can be demonstrated on old specimens that have been relaxed, the present species (*musculus*) is less robust, thorax less rounded on the sides, and suture always darker."

A. musculus Say is smaller than *A. suturalis* Lec., ranging from 1.5 mm to 2.0 mm. in length while the latter ranges from 2.3 mm. to 3 mm. in length. In general shape, *musculus* is less oblong, somewhat widening behind while *suturalis* does not widen behind, the sides remaining parallel; the antennal funicle of *musculus* is stouter and club more abruptly formed than in the latter species; the sides of the thorax of *musculus* are more rounded and more transverse, apical constriction shorter; upper side less shining, punctuations finer and denser, hairs coarser and longer; elytra distinctly shorter in *musculus*, widening behind; striae less impressed with puncture less coarse; pubescence coarser, usually forming two transverse bands, these bands never occurring in *suturalis;* color red, brown or black (in *musculus*), with or without a black spot behind the middle; very rarely black with tip indistinctly dark red; color black (in *suturalis*) with a large usually well defined apical spot yellow or red.

Suturalis has been found to breed in Phylloxera galls on Hickory leaves and is frequently found in such galls, while *musculus* has never been reported from galls or from hickory.

NATURE OF INJURY

Although the over-wintering beetles do some feeding on the cranberry in late May and early June, most of the damage is done just before egg laying and again in July when the newly-emerged weevils attack

the fruit, leaves, and terminal buds. The most severe injury done during late May and early June is caused by the weevils feeding upon the new terminal growth. They feed ravenously on the new leaves and tender blossom-buds. In many cases they bore into the very basal portion of the new leader so that the latter dies back to the old wood, turning black in a few days and giving all the appearances of having been killed by frost. Within a few weeks a new shoot takes the place of the dead leader, but of course, bears no bloom that season.

Immediately prior to and during egg-laying, the adults drill into unopened buds to devour the contents (immature floral parts), and, in so doing, often make several holes in one bud. The bud naturally never opens, but dries up on the pedicel and eventually drops off. Each blossom bud in which an egg is deposited becomes the food of the hatching larva and therefore never matures.

As soon as the young beetles emerge from the pupa stage they at once attack the immature cranberries and riddle them in short order. The hungry weevils drill anywhere from one to thirty holes in a single berry, gouge out the interior, and then attack another. Such fruit as may escape drilling continues to grow, and apparently becomes too tough for the beetles, for they soon turn their attention to the terminal buds and new leaves, riddling them also. During the first part of August, they gradually cease eating, and, by the middle of the month, no trace of recent feeding can be found.

Life History and Habits

The over-wintering adults make their appearance soon after the coming of warm weather, usually about the middle of May. By sweeping over the cranberry vines with an insect net on warm sunny days in mid-May, many specimens can be taken on infested bogs; but, during cold, windy, or cloudy weather, at that time of year, only a few beetles can be thus obtained. On such days they may be found, however, on the bog floor, inactive and often apparently lifeless. On hot days the beetles appear to be at their height of activity, running up and down the vines, often taking flight. When disturbed, they may "play 'possum" and drop to the ground with their legs folded tightly against the thorax and abdomen, or may spread their elytra and fly off a few yards.

Towards the end of May the weevils start feeding upon the old leaves, unopened terminal buds, and such new growth as may have started. Most of the eating on the old leaves is done on the lower epidermis, but the injury resulting from this is of little account. The

most serious damage at this season of the year is caused by the beetles drilling into the buds and base of the terminal growth. They exhibit no fixed manner of feeding as do many species of weevils (some weevils of the same genus have been observed to feed head downward), but drill into the edible parts of the plant while standing at any angle. As they feed on the new leaves and blossom-buds, they leave small spots of excreta, which under a lens appear as moist, dirty-green drops.

By the first of June the beetles start mating. The writer, in collecting them, placed several specimens in a single vial. When a male and female met, copulation began at once. Beetles in captivity were found *in coitu* at any time of the day and apparently under any conditions. If disturbed, they separated, only to mate again in a few minutes. Copulation lasted from a few minutes to several hours, usually less than a half hour.

Egg Deposition.—The eggs of this insect are deposited singly, one to a bud, and in the majority of cases are placed by the female in the blossom-bud at the bases of the anthers. The process of depositing the egg is interesting. The female drills a hole by first chewing an opening through the petals. She then slowly "worms" out a passage into the interior of the flower by rotating her whole body on her beak as a pivot, until she has drilled to a depth equivalent to the length of her beak. This process requires from ten to fifteen minutes. Upon completing the hole, the female withdraws her beak, turns around and feels over the surface of the bud with the tip of her abdomen until she locates the hole just drilled, inserts a short ovipositor, pushes an egg into the opening and walks away.

It has been reported (6) that the female cuts off the blossom after depositing the egg, but the writer has observed this only in a few cases.

Egg-laying may extend over a period of three or four weeks, depending upon the development of the cranberry bud and upon weather conditions. Eggs have been found in the "pod" stage of blossom development, i. e., when the blossoms buds are just beginning to show pink, before they have become advanced enough to droop over. This period necessarily varies with the season and with the time of removal of winter flowage, and may occur at any time between the first of June and the third week in June.

Females reared in the laboratory deposited as many as thirty-nine eggs in a season, and the average number of eggs laid per female was twenty. The period of greatest activity in laying seems to be dependent on temperature to a considerable extent, as on the very hottest

days (shelter maximum temperature of 93° to 100° F.) females laid three or more eggs, while on cooler days only one, and on cold days none.

LARVAL HABITS.—The eggs hatch in from three to nine days, also depending on temperature. In June 1924 (the spring of 1924 was cool and wet) eggs hatched, on an average, seven days after they were deposited. During 1925 eggs hatched on an average of four days after having been deposited during the very hot period mentioned in the previous paragraph.

The young larvae at once begin to gnaw through the anthers, then devour the stamens and pistil, and finally eat away the interior of the immature ovary. The petals and outer skin of the ovary are left intact throughout larval life. It is very interesting to note that the petals, instead of curling away from the pistil and stamens (as they normally would do on an injured blossom), remain tightly closed together, in time becoming stiff and dry in this position, so that a protective cell is formed enclosing the larva and pupa.

PUPATION.—Pupation takes place within the above mentioned cell from ten to fourteen days after the hatching of the larva. The pupa is at first white throughout, but in a few days the eyes become dark. Pupal life extends over a period of from five to seven days. When disturbed or jarred vigorously, the insect in this stage twists and turns by rotating the last few segments of the abdomen in rapid, jerky gyrations.

ADULT LIFE.—The beetles emerge from about the 26th of June to the 10th of July and at once commence their feeding activities. At this period of their life, they are most voracious, attacking the immature fruit, the new leaves, and the terminal buds. Through the early part of July, vines on a badly infested cranberry bog may be overrun by the young beetles. After the first week in August, little eating is done and the adults begin searching for their winter quarters. By the middle of September, few or no beetles can be found on the vines. Adults were found during October on the bog bottom under the trash and fallen leaves, only after careful and prolonged searching. It may be possible that some migrate to the surrounding upland and hibernate, but no beetles have been found on the upland to prove this. There is, then, but one generation a year in Massachusetts.

NATURAL ENEMIES

A chalcid fly, determined by Mr. A. B. Gahan of the Bureau of Entomology, U. S. D. A., as *Habrocytus* sp., was reared from the cranberry weevil. No other natural enemies have been observed.

Control

Late holding of winter flowage is a common practice in attempting to control many cranberry insects. This measure was tried on one bog, but apparently had no ill effect upon the weevils as they appeared in abundance three days after the winter water was drained off. The bog in question was held under water until May 25, 1925.

Another control measure[3] was tried in connection with sanding. Cranberry bogs are usually sanded every few years to keep down moss and weeds, and to keep the root system of the cranberry well aerated. Usually a coating about one-third of an inch in depth is spread on the bog early in the winter. In the control work, one plot was left unsanded, another sanded in the customary way, and a third sanded very heavily. This was done during November 1924. Late in May 1925 an examination of the unsanded and sanded areas showed that the beetles were twice as abundant on the sanded plots as on the unsanded. This may be accounted for by the presence of a comparatively rank growth of tender, new uprights on the sanded plots, a condition which always exists after re-sanding. This growth of fresh food undoubtedly attracted the weevils. Then too, "sanded bog" is usually several degrees warmer than "unsanded bog," and the warmer areas might be attractive to the weevils during the cool spring nights.

Field tests were conducted with several insecticides and spray mixtures. Nicotine sulphate (both as a dust and as a spray) was tried and proved of no value as a control. Lead arsenate spray, calcium arsenate dust, sodium fluosilicate (as a spray and as a dust), cryolite spray, and a mixture of Bordeaux, calcium arsenate, lime and fish-oil soap were each used in an attempt to combat the insect. The latter gave promise of being most effective during the first season and was recommended in 1925 as a practical spray. In every case where it was used, either experimentally or commercially, very satisfactory results were obtained. The following table brings together briefly the results of the various insecticides used in experimental control.

It has been found advisable to apply the Bordeaux spray just before the buds begin to show pink. It is then that the weevils are very active and it controls them before they have an opportunity to lay their eggs for the summer generation. The pink stage (known as the "pod" stage) varies with the season and according to the length of time the winter flowage may be held on the bog, but usually is during the early part of June.

[3]This phase of the control work was carried out by Dr. H. J. Franklin.

COMPARISON OF EFFECTIVENESS OF THE SEVERAL INSECTICIDES USED IN EXPERIMENTAL CONTROL OF THE CRANBERRY WEEVIL

Insecticide	% Kill	Remarks
Bordeaux mixture, calcium arsenate, and fish-oil soap mixture.	100	This combination sticks to the foliage very well, does not burn, and is not costly.
Same as above	91	Applied too late in the season.
Calcium arsenate and lime dust, 1 to 5 (500 lbs. per acre).	100	To get good control it is necessary to dust very heavily. Cost prohibitive.
Lead arsenate and "Sunoco" spray oil (for spreader).	81	Only fair control
Lead arsenate and "Kayso."	66	Not satisfactory.
Cryolite, 1 lb.; lime, 2 lbs.; water, 25 gals.	78	Only fair control.
Same as above, twice the strength and lb. fish-oil soap.	72	Only fair control.
Same as above, no soap.	72	Only fair control.
Sodium fluosilicate and lime dust (1 to 4).	65	Some injury where dust lodged heavily.
Sodium fluosilicate, 2 lbs.; lime, 4 lbs.; soap, 1 lb.; water 25 gals.	55	Considerable injury by burning foliage.
Nicotine sulphate sprays and dusts of all grades.	0	Of no value against this pest.

The Bordeaux mixture, lime, calcium arsenate, and soap mixture should be made up as follows:

Bordeaux mixture	Lime (slaked)	4 gallons
	Copper sulphate	3 gallons
	Water to make	50 gallons
	Calcium arsenate (powder)	3 pounds
	Fish-oil soap	2 pounds

Slake carefully the desired quantity of stone lime. Dissolve three pounds of copper sulphate (blue vitriol) in three gallons of water. Dilute the lime mixture and copper sulphate solution with water to twenty-five gallons each, and pour together into spray tank.

Add three pounds of calcium arsenate to a gallon or so of the above mixture in a pail, and stir well. Pour this into spray tank and add a quart or two extra of the lime water.

Mix two pounds of fish-oil soap in a little water and add to the spray mixture immediately before spraying. Agitate the whole thoroughly. This should be applied at the rate of 300 to 350 gallons to the acre.

The Bordeaux acts as a sticker (9), and "body" or "carrier;" the soap as a "spreader." It has been found by extensive experimentation that the above described mixture is one of the best "stickers" and "spreaders" that can be applied to the cranberry. The mixture will

spread exceptionally well over the waxy cuticle of the cranberry leaf and fruit, and will withstand the washing effect of many rains without materially losing its toxicity. Furthermore, no trace of foliage injury could be found after spraying.

It will be observed that an excess of lime is present in the above mentioned mixture (instead of using the regular 4–4–50 formula, only 3 gallons of copper sulphate are used so that there will be a considerable excess of lime). This will take care of any arsenic rendered soluble by the addition of soap to the calcium arsenate. Otherwise foliage injury might occur through the presence of soluble arsenic. As a rule, the use of soap with an arsenical is not recommended, but in this case it is quite safe, *provided more lime is added as stated and that the soap is put in the mixture last.* A quart or two extra of lime should be added to every fifty gallons of the mixture as a precautionary measure.

Cost of Materials

Bordeaux, Calcium Arsenate, and Soap

Copper sulphate	18 pounds at $.10		$1.80
Lime (lime stone)	24 " " .01½		.36
Calcium arsenate	18 " " .18		3.24
Fish-oil soap	12 " " .08		.96
Water	300 gallons		
Total cost of material necessary to spray one acre			$6.36

There are some growers who during early summer make weekly or semi-weekly examinations of their cranberry property, sweeping with a collecting net here and there over the bog to get some idea of the abundance of insect life inhabiting it. Even then the minuteness of the cranberry weevil serves to prevent the casual observer from detecting its presence unless the insect is there in great abundance. The importance of a weekly or, better, semi-weekly examination of a bog cannot be overemphasized, and a careful scrutiny of the contents of the collecting net during such expeditions should be emphasized still more.

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TELENOMUS COSMOPEPLAE GAHAN, AN EGG PARASITE OF *COSMOPEPLA BIMACULATA* THOMAS

By W. V. BALDUF[1]

ABSTRACT

Cosmopepla bimaculata Th. was common on snapdragon, and is regarded as a potential pest. It was found to be held in check by *Telenomus cosmopeplae* Gahan, a new species of Serphoidea. The manner of oviposition, larval habits, life cycle, and economic value of the parasite were determined. *Triphleps insidiosus* Say is suspected of reducing the effectiveness of the parasite by preying on the *Cosmopepla* eggs, both parasitized and unparasitized.

The common small red and black Pentatomid, *Cosmopepla bimaculata* Thomas, is a potential pest of ornamental snapdragon grown in gardens here. It was found, however, to be held in check to a large extent by a Serphoid egg parasite which Mr. Gahan of the U. S. Bureau of Entomology pronounced a new species, *Telenomus cosmopeplae*,[2] Family Scelionidae. The present paper embodies the results of observations on its life cycle and habits as noted at Urbana, Illinois, in the summer of 1925.

NOTES ON THE HOST

The first adults of the Pentatomid host, *Cosmopepla bimaculata* were found on July 14, 1925. The facts that they were common, that no nymphs occurred, and that many were *in copulo*, suggest that the species winters as adult and that these individuals represented the first generation of the year. On July 19, masses of the eggs were discovered. The nymphs had hatched from one of them, and small nymphs were first seen on July 20. The eggs are sometimes laid in clusters of twelve,

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[1]Contribution number 104 of the Entomological Laboratories of the University of Illinois.

[2]Gahan, A. B., Proc. Ent. Soc. Wash., Vol. 28, p. 67, 1926.

and placed side by side on various parts of the plant, but some are deposited singly or by twos and other numbers under twelve. On September 30, the nymphs and adults were less plentiful, and parasitized eggs occurred much more commonly than during July. A few individuals of both these stages were still present on the plants on October 14, and a mass of eggs was discovered on the same date. No copulation could be noticed on the latter date and for days theretofore which again argues that the winter is passed in the adult state. Perhaps two or three generations develop annually. Both nymphs and adults attack the snapdragon, most of the feeding being done about the buds and the distal parts of the stems.

How the Host Egg is Parasitized

The manner in which the parasite gains entrance to the host egg was observed in a number of instances, and the process proved to be the same in all cases. In the first instance, four adults were introduced into a vial containing two masses of eggs. All the insects ran over the eggs but only one gave particular heed to them. This individual paused at once by the mass of five, and after tapping the eggs several times with its antennae, it turned end for end, exserted its short straight ovipositor and backed it into one of the eggs. The act of inserting this instrument is always accompanied by a series of forward and backward movements of the body. Thereupon the parasite remains quiet with the exception of occasional slight vibratory movements of the body or some of its parts.

In ovipositing, the insect occupies one of two positions. Most frequently it occurs on the tops of the eggs just before egg laying, and upon proceeding to oviposit backs down partly between juxtaposed eggs so that the ovipositor enters obliquely into the side. In such instances the egg is punctured just beneath the crown of hooklets that adorns the top of these eggs, or on the top of the eggs within this circlet of hooks. But when the parasite selects an egg on the edge of the mass it may rest on the leaf surface bearing the eggs and back the ovipositor into the lower half of the host and more or less at right angles to its vertical axis.

When the ovipositor was once inserted, the parasite remained at successive eggs for somewhat different periods of time. The following figures represent the number of minutes spent successively at as many eggs: 4.5; 3.75; 6.0; 2.5; 3.0; 1.75; 2.5; 2.0 and 2.33. The total time required for this work, including the intervals between successive ovipositions, was 48 minutes, whereas the total time actually spent in ovipositing was 33.33 minutes or an average of 3.33 minutes per egg.

The remaining 14.67 minutes were spent in two ways;—first, oviposition was sometimes interrupted by interference by other parasites in the cage, in which instances the ovipositing individual prematurely forsook the egg, and in some cases exhibited its objection to the disturbance by driving the intruder away; second, most of the intervening time is consumed in activity incidental to egg deposition. Before the ovipositor is thrust into the egg the parasite makes studies of the eggs, in which it crawls over the mass and constantly vibrates the antennae, always striking them against the top and various sides of the egg. When the insect is satisfied, the ovipositor is inserted, but this may be preceded by several separate visits and tests of the various eggs. When the parasite egg has been passed into the host egg, the ovipositor is withdrawn promptly, but before leaving the egg the insect brushes the same several times with the still protruded ovipositor. This characteristic act may have a definite function. Whether it serves merely to wipe the ovipositor, to apply glandular secretions of its own, or to seal the wound by rubbing over it the egg substance that was drawn from the egg incident to pulling the ovipositor out, is a matter of speculation. However, that it does not always serve to seal over the puncture hole was shown by watching the act with a high power microscope. In this instance the ovipositor was applied thus at a point below the puncture.

In some manner, nevertheless, whether by tactile sense stimulated by the slight hump of egg substance drawn out when the ovipositor is removed, or by a chemical sense stimulated by the peculiar odor of the insect itself on eggs already visited, the parasite is able in most cases to avoid repetitions of oviposition in the same egg. In the above instance the parasite did not repeat in the first mass that consisted of five eggs, even though it made several inspections of the whole mass. In a good number of similar observations, the parasite avoided duplication in a large per cent of the eggs, and visited a relatively small number twice, and a still smaller number three times. Repetition seems to result from weariness and a consequent decline in alertness, or from failure of the insect to find sufficient eggs to satisfy the impulse to oviposit in one given period. These possible explanations are suggested by the fact that most of the superparasitism takes place after the parasite has made the rounds of the available eggs or has parasitized ten or more.

In other instances, the parasite performed in essentially the same way as described above. The details from another case may be presented most simply in tabulation. In this instance, the mass of twelve eggs used was diagrammed and each egg given a number.

OVIPOSITION BEHAVIOR

Egg No.	Duration of oviposition in minutes	Intervals between ovipositions	Conduct of parasite during intervals
1	2.5	1 and 2—0.5 min.	Stroked egg with ovipositor; tested eggs with antennae
2	6.5	2 and 3—0.5 min.	Same
3	3.5	3 and 4—0.5 min.	Same
4	4.0	4 and 5—1.0 min.	Same
5	4.0	5 and 6—1.0 min.	Same
6	6.0	6 and 7—2.0 mins.	Same
7	4.3	7 and 8—1.0 min.	Same
8	3.5	8 and 9—1.0 min.	Same
9	4.0	9 and 10—1.5 min.	Same
10	4.0	10 and 11—2.0 mins.	Same
11	5.3	11 and 6—1.0 min.	Same
6	5.6	6 and 12—2.5 mins.	Same
12	6.5	12 and 11—1.5 mins.	Preening
11	4.5	11 and 1—6.5 mins.	Rested five minutes.
1	4.0	1 and 3—2.75 mins.	Tested eggs one min. As for eggs 1 to 11.
3	5.7	3 and 11—3.25 mins.	Same
11	2.75	11 and 9—	Observations ceased.

These acts were performed in a period of exactly two hours. It will be seen that the parasite visited the first eleven eggs without repeating, but in the latter part of the period duplication took place as follows; egg 11 was visited three times, and eggs, 1, 3, 6, and 8 twice each. These instances of error are quite closely correlated with the increase in length of the intervals between ovipositions. The errors would therefore seem to result from physical exhaustion. Eighteen acts of oviposition were performed. The average time spent with an egg was four and forty-five hundredths minutes, with an average interval of two minutes required for stroking the eggs with the ovipositor and for resting, preening and testing the eggs in preparation for another oviposition act.

Two other observations on the parasite seen in the act of ovipositing were made. The first mass contained seven eggs, and the parasite inserted the ovipositor successively in each without duplication. It remained in connection with the several eggs through periods of minutes as indicated here, the figures in parenthesis representing the duration in minutes of the intervals between the successive ovipositions: 3.5 (0.5); 6.5 (0.4); 3.33 (1.0); 3.5 (1.5); 1.5 (8.0); 3.7 (3.66); 4.5 (3.5).

A female with matted wings, when placed with eggs of *Cosmopepla*, proceeded to oviposit almost at once. The entire record is 3.0 (1.0);

1.33 (2.33); 3.66 (15.5); 3.0 (6.0); 2.66 (parasite left the eggs at this time). Most of the time was therefore spent in non-oviposition activity. Other individuals introduced at the same time bristled up when they discovered the eggs, but did not proceed to oviposit, and invariably left the eggs at once. All, including the matted winged individual, seemed sluggish and sleepy; the day was cloudy and artificial light was used. The insects were reared on September 29, and the observations made on October 2, 1925. In other efforts to have the parasite oviposit, the insect spent the time in preening and seemed disinclined to infest the host even when resting near them or even upon them.

It is not known whether an egg is inserted every time the parasite inserts the ovipositor for the usual period. A small number of the above eggs that were seen to have been visited more than once were dissected, and while one egg was always obtained, more were never taken, although according to evidence in one known case two eggs were probably inserted. Furthermore, the parasite seemed rarely, if ever, to inject more than one egg at one visit to a given host egg.

The Newly Laid Egg of *Telenomus cosmopeplae*

One of the above parasite eggs removed from its host egg an hour after it was laid exhibited an oval body, with the caudal end moderately rounded and a cephalic stalk having a broad base and a distinct but gradual curve terminating bluntly. Its total length was 0.20 mm., and the body and the tail were about the same in their longitudinal dimension. The color was light, and the surface unsculptured.

Incubation

To avoid the difficulty in handling the small taut bouncy host eggs, they were set in a thin smear of glue in the bottom of a watchglass. In an hour the hardening glue held them secure, making much more successful the delicate task of removing minute eggs or larvae without injuring them. By placing them on the binocular stage and using the low power, the eggs were picked open with sharply pointed dissecting needles.

Eggs infested on August 5 contained newly hatched parasites 46 or 47 hours after the parent *Telenomus* had visited them. Another series of eggs that were numbered and the exact time of whose infestation by the parasite was known, was likewise examined. Eggs were opened one at a time, about one hour after the other, beginning about four hours after the first parasite egg was inserted.

A somewhat detailed record of what was seen will disclose something about the manner of development as well as the incubation period. A parasite egg three hours and fifty minutes of age was 0.20 mm. long, the stalk being 0.07 mm. long by 0.013 mm. thick, and the egg body 0.156 mm. long with a maximum diameter of 0.07 mm. Thus, the stalk has already shortened as compared with that of a newly deposited egg, in which stalk and body were of approximately the same length. It was not possible to note any marked embryonic development at this time, but it was no doubt already well begun.

The second egg was five hours and forty minutes old when obtained from the host, and had become less ovate, approaching more nearly a spherical form, and the petiole was still as before. The petiole was found to retain about the same size in proportion to the egg throughout the rest of the embryonic growth. At this age the egg measured 0.24 mm. in length, body 0.16 by 0.12 mm., and petiole 0.08 mm. by 0.13 mm. In this egg also no structural developments were noticeable, but in the third one examined, aged nine hours, the body viewed from above had already become well developed. The vitelline membrane was slightly separated from the chorion as in eggs of other ages. When seen in sideview the back appeared distinctly arched, and structures were definitely visible on the venter. The caudal spine, the mandibles, and the peculiar ventral notches present on newly hatched larvae had already appeared, the spine lying parallel and contiguous with the inner wall of the egg. In other words, the appendages characteristic of the first instar larva formed in the first nine hours after oviposition, and the duration of the egg stage is not greatly longer than that period.

The nine hour egg, in dorsal aspect, had the following dimensions: total length, 0.26 mm.; body, 0.17 mm. by 0.12 mm.; petiole 0.09 mm. by 0.13 mm. Hence, there is but little difference in the size of the egg at various ages, the chief change being in the dimensions rather than volume, the latter being only moderately increased, and the petiole distinctly abbreviated but not lost as in some of the Braconidae. This appendage was present in full on an egg from which the larva was just hatching.

The next *Cosmopepla* egg was examined ten hours later than the preceding, and the parasite larva had already emerged from its egg, and the alimentary tract had already been well filled with yolk. Incubation in *Telenomus* is therefore less than eighteen and a half hours, and without doubt only about ten to twelve hours on warm days in August.

The Young Larva and its Activities

The newly hatched *Telenomus* possesses structures[3] that have either been held over from their earlier state, or that represent strictly temporary organs of an adaptive character. The small narrow head bears proportionately large falcate-form mandibles, each situated upon a slight prominence, and directed caudo-ventrad when at rest. On the venter of what appears to be the mesothorax there is a single median, short, sharp process directed forward, which possibly opposes the mandibles when it functions. On the anterior region of the abdomen a band of about fifty conspicuous hairs almost one-fourth the length of the larva completely spans the body. At rest they lie back against the abdomen, but during locomotion they are alternately extended at right angles and brought to rest again. In this way they seem definitely to aid in movement, either as propellers, or more likely as rudders that work toward steadying the insect in its course. On the venter near the tip of the abdomen arises a very prominent hook about half the length of the entire body and directed forward. It is somewhat flattened sidewise, tapers to a sharp point, and on its anterior edge bears a sub-basal tooth which also points forward. In one instance a larva was observed with the petioled part of its egg shell still in place over its head. Larvae removed from their hosts remained alive as much as an hour in moderately warm water, hence their activity could be easily studied. In traveling, the insect doubles the front and hind portions of its body ventrad so that the extended mandibles reach to the abdomen, and the caudal hook reaches considerably beyond the head. By such doubling movements alternated with the corresponding straightening out of the body the larva succeeded in kicking the shell off its head. It is probable that by similar lashing of this caudal hook the original breaking of the egg incident to hatching is accomplished.

That the larva eats the yolk of the host egg is known from the presence of bright yellow yolk in the body of the parasite, from the gradual depletion of the yolk supply as the larva grows, and from observations on the activity of the larva in the egg host. Feeding seems to be accomplished only incident to locomotion. It always travels on its back, hence the caudo-ventral hook is situated favorably to perform its several functions. When the body is extended the mandibles are thrust forward; when the body doubles up, the mandibles are pulled back

[3]See McColloch and Yuasa, Chinch Bug Egg Parasite, Jour. Ec. Ent., Vol. 8, 251, Fig. 11, B. The larva of Cosmopepla is as shown in this figure, excepting that it possesses a denser band of hairs which extends entirely around the abdomen.

against the mouth situated on the venter of the head. Thus, globules of yolk are brought to the mouth by the mandibles that act as scoops. These rhythmic movements for locomotion and feeding are made quite continuously and at the rate of about thirty complete vibrations per minute.

Aside from the mandibles, band of hairs and caudo-ventral hook, the form of the larva is quite simple. The segmentation can no longer be readily discerned. The limits of the body region are also poorly defined. Almost directly above the head is a distinct hump, which belongs to the thorax, and ventrally the surface of this body region is notched at several places. Otherwise the form of the thorax is somewhat uniformly cylindrical and seems to be marked off from the abdomen by a broad shallow constriction and the band of hairs that encircle the front margin of the abdomen. The abdomen is quite plain, with the exception of the caudo-ventral hook already described. The newly hatched larva was found to be 0.22 mm. long, and about 0.09 mm. in maximum diameter, and whitish in color.

The only internal structure that could be distinguished was the alimentary tract. It arises at the base of the mandibles, extends backward and dorsad by a short narrow cylinder, which is perhaps the esophagus. Thereafter it broadens and thickens abruptly in some individuals and assumes sizes and shapes that differ greatly according to the amount of yolk swallowed. It may be described as being generally pouchlike, and is blind as in all other instars, and broadly rounded behind. Its dimensions and outlines are readily traced when filled with the yellow yolk. Apparently the esophagus is also capable of considerable expansion inasmuch as it was found to assume various lengths and diameters in different larvae,—when little food was present it was long and slender, otherwise correspondingly shorter and enlarged in diameter.

In only one instance was evidence found to indicate what happens when more than one larva arises in the same egg. In this case an adult parasite paid two visits to this egg within one hour. Ten hours after the time required for the egg to hatch had elapsed, it was opened. One normal, entire first instar larva, and another represented by a part of the transparent body wall to which a number of dishevelled hairs of the abdominal band was attached, were present. Cannibalism seems therefore to exist, thus ensuring the success of the parasite as a species at the expense of some individuals in such cases. Obviously, two individuals could not mature in a single egg even though one were not lost by fratricide.

The duration of the first instar during August was less than two days, as determined in one instance. At the age of twenty-nine hours it had already shed the characteristic first instar structures—the pronounced mandibles, the band of hairs encircling the abdomen, and the large curved caudo-ventral hook.

Development and Behavior After the First Instar

Judging alone by gross differences in form of body, the larval stage of *Telenomus cosmopeplae* comprises three instars. The second and third are readily distinguished from the first by the characters already enumerated. In the second instar the mandibles appear still to be sufficiently developed to be functional. The body becomes flattened, and broader at the middle, and distinctly and gradually narrowed toward the front and posterior ends, or elongate oval in outline. Now the larva no longer travels about so much as in the first instar. The possibility of locomotion is less, due to the increased size of the larva. Movement is still accomplished by the alternate doubling of the ends of the body ventrad and their subsequent extension.

Another notable change in form appears in the larva, in what is supposed to be the third instar, in somewhat more than a day after it goes into the second instar. The body becomes quite discus-shaped, or circular in outline from above, and flattened, but slightly convex on the dorsal and ventral surfaces. While examining the live insect in this instar and in the host egg, it was found to be sensitive to changes in the position of the host, the larva being discernible while it moves to orient itself to these changes. While still capable of movement, it gradually grows so large in this instar that distinct locomotion is impossible, or is at least rarely seen.

At the age of three days and nine hours, one larva was removed from the Pentatomid egg. The size of the insect as compared with the host egg indicated that the larva was approaching maturity. It was then almost circular in outline, both the transverse and the longitudinal diameters being 0.55 mm.

Effect of Parasitism on the Host

Parasitism, especially if the parasite succeeds in reaching the first instar, prevents the embryonic development of the host. It was observed repeatedly that eggs which had proceeded so far as to make the pink eyes of the embryonic nymph visible through the top, were selected by the parasite quite as readily as were the younger eggs. Thereby it became obvious that eggs in any stage of development were killed soon

after the parasite hatched. The definite arrangement of the embryonic tissues was promptly and effectively disrupted by the whipping, vibrating action of the parasite's body. The falcate mandibles and the long, sharp, lashing caudal hook are admirably fitted to disorganize the contents of the host in almost any stage, save perhaps that just before hatching. Whether the pink eyes were apparent, or the egg was newly deposited, the substance was reduced to a homogeneous mixture as the result of the churning effected incident to the locomotion of the parasite. The first instar larva and the later forms also for most part, occupies the lower half of the egg. During the larva period the yolk store of the host is quite entirely consumed. However, at the time of pupation some solid residue is always present. This substance is yellowish, flexible and gelatinous in texture, and assumes the form of an elongate strip, with moderate thickness and tapering to sharpness at the edges. Although the exact source of the substance was not determined, it probably represents the undigestible accumulation of food matter thrown off in the peritrophic membrane by the mature larva at the time of pupation. This mass, which appears granular or composed of minute globules, seems to be enclosed in a very thin transparent sac,—possibly the peritrophic membrane. Inasmuch as the digestive tract is blind posteriorly, and no other substance that may be regarded as the discharge of the larva can be found in the egg when the parasite is a pupa, it seems that this gelatinous strip of matter in all probability comes from the alimentary tract of the mature larva. It is almost as long as the mature larva, and considerably more narrow, hence, it is physically possible that it develops in the larva stage. If so, its gelatinous nature is due to the fatty food consumed by the larva, whereas the discharge in phytophagus chalcidoid Hymenoptera has been observed to be dark in color and in the form of tiny spherical pellets.

Within about the last day of the larval stage the color of the host egg turns from yellow,—first to smoky, then cloudy dark and eventually to pitch black. Hence, eggs containing an almost mature larva, a pupa, an adult, or even forsaken by the adult parasite, can be recognized at a glance by their dark color. Careful examination revealed that the black material resides in the vitelline membrane and not in the chorion. Normally both these layers of the host egg are whitish and semitransparent, the yellow appearance of the unparasitized egg being due to the contents of yolk.

The Pupa and its Development

During transformation to the pupa state the insect loses the flattish, circular form it has as a larva, and assumes the typical shape of other

Hymenopterous pupae. The pupa stands on its caudal aspect with the head just under the dorsal end of the host egg. The gelatinous strip described above lies flat on the bottom and against one side, extending about half way to the top of the egg. Between it and the opposite side of the egg the pupa is wedged, facing the cavity of the egg, and its dorsum is braced against the outer wall.

The newly transformed pupa is white, but the eyes turn pink, then orange within the first two days. Little data was obtained on the duration of this stage, but in all probability it requires no more than four or five summer days to pass. Whereas the Pentatomid nymph, in hatching, escapes by lifting the neat circular cover crowned with the row of hooklets, the parasite adult utilizes its mandibles and cuts a ragged hole through the top within the circlet of hooks.

The pupa stage seems to be the most precarious in the cycle of the parasite. Many black eggs taken from the garden and kept for weeks in cages failed to yield adults at all or required more than the usual period in which adults develop. Pupae of all the usual gradations in color between white and black were removed dead from eggs fresh from out of doors. Assuming that fatalities were due to excessive evaporation both in the laboratory and in the hot, dry atmosphere of the summer of 1925, several masses of black eggs past due to hatch were given a liberal soaking with water. As a consequence a larger percentage of parasites appeared than was obtained otherwise.

The Adult and its Behavior

The adult *Telenomus cosmopeplae* is minute,[4] the body having a length of only 0.81 mm. to 0.89 mm., and the wings when flat on the body extend 0.28 mm. beyond the tip of the abdomen. The entire body is pitchy black. Adults were at various times seen nibbling at the outer surface of the host egg, and were never observed feeding at the ovipositor punctures. They also fed on honey provided in their cages. Mating was seen in a few cases.

The Cycle and Generations

The total time required for *Telenomus cosmopeplae* to incubate and proceed to the point of emergence of the adult from the host egg is between nine and ten days. In addition to this piecemeal evidence on the duration of the cycle as obtained from a study of the host eggs para-

[4]For a complete technical description see Gahan, Proc. Ent. Soc. Wash., Vol. 28, 1926, p. 67.

sitized out of doors, it is known that the eggs turn black when the parasite larva is about full grown, or approximately five days after the time it was inserted as an egg into the host. Consequently it is likely that at least from two to three generations appear per month during the most favorable period of the year, and the species can increase rapidly in number of individuals. The first black or parasitized eggs were discovered on August 1, but such must have occurred theretofore. *Cosmopepla* was mating and laying commonly on July 14, and the eggs and nymphs found on July 19 and 20 were probably among the first of the season. Infested eggs were common thereafter and a few adults were reared after October 28. Development is therefore known to continue over a period of at least three months,—July 27 to October 28. Because *Cosmopepla* eggs were not present until about the middle of July, parasitism could not have begun more than about two weeks earlier than the known records. The species is presumed to winter in the adult state.

Percentage of Parasitism

Five hundred and eighty-four *Cosmopepla* eggs collected from snapdragon from August 3 to September 30 were examined to determine whether they had been injured by natural enemies or gave promise of producing *Cosmopepla* nymphs. Out of this number, 198 or 33.9% were either dusky or black, 239 or 40.92% had a healthy yellow to orange color, and 147 or 25.17% were empty with the shell clear and quite intact. There is strong evidence that the clear and empty eggs had been sucked out by *Triphleps insidiosus*. Facts leading to this conclusion are its known predatory habits, its small size, its common presence on snapdragon, and the occurrence of a cone-shaped protuberance of dried yolk on the outside of such eggs. Not uncommonly empty eggs were black, or dusky in hue, indicating that the predator attacks eggs containing *Telenomus* as almost mature larvae, as pupae, or possibly even as adults, and certainly eggs containing only the egg stage of *Telenomus* were often destroyed by the same agency. The parasite, while potentially capable of keeping *Cosmopepla* in check, is itself incapacitated by the effective work of the predator, whose influence is greatest in latter summer when the parasite also would reach maximum numbers. It should be noted that even though 239 eggs appeared superficially free from parasites, some of them certainly contained the eggs or very small larvae of the parasite, which stages do not cause the eggs to turn black. The per cent parasitized was there-

fore more than 33.9. The large number of eggs laid by *Cosmopepla* proves its potentiality for being a serious pest on snapdragons, and its failure to realize this capacity must be credited to a very considerable extent to the efficiency of the tiny *Telenomus cosmopeplae*.

THE EFFECT OF MOISTURE, TEMPERATURE, AND LIGHT ON THE DECOMPOSITION OF LEAD-ARSENATE IN SULFUR-LIME DRY MIX SPRAY[1]

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ABSTRACT

Large amounts of water soluble arsenic are liberated when sulfur-lime dry mix spray containing acid lead arsenate is exposed to the atmosphere in thin layers on glass plates. This is brought about by the calcium carbonate formed from the hydrated lime. Still greater percentages of soluble arsenic are formed when the $Ca(OH)_2$ is entirely replaced by $CaCO_3$. Apparently high humidity, intense sunlight and a temperature of 110°F., singly or combined, do not play any significant role in decomposing the $PbHAsO_4$ but may cause arsenical injury to foliage indirectly by increasing the permeability of plant tissue to water soluble arsenic.

The introduction of sulfur lime dry mix (3) in New Jersey as a substitute for self-boiled lime-sulfur offers an ideal summer spray. When mixed with lead arsenate, it serves as a combined insecticide and fungicide and is manipulated with greater ease than the various lime-sulfur mixtures in liquid form. Recently, however, considerable injury on foliage and fruit of apple and severe injury on young wood of peach trees with partial defoliation and wood cankering was observed as a result of spraying with the 4–8–50 dry mix, containing one or one and a half pounds of lead arsenate. This formula calls for four pounds of hydrated lime, eight pounds of sulfur, and half a pound of Kayso (casein and lime) to fifty gallons of water. The injury occurred mainly in Central and in South Jersey.

That this injury to peach may be directly attributed to the lead arsenate and not to the other ingredients present in the spray has already been definitely established (6) at this Station. Furthermore, the problem became more complicated because weather fluctuations were thought to be important factors. Injury was more pronounced in New Jersey during the summer of 1922, when wet and humid conditions

[1]Paper 291 of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

prevailed than in 1923 which was an exceedingly hot and dry season. This interesting phenomenon again brought up the still mooted question concerning the part that atmospheric conditions play in arsenical burning.

The problem of arsenical injury to plants in general has been under discussion in our scientific literature ever since insecticides containing compounds of arsenic came into use. Evidently the introduction of the newer and more stable arsenates of lead and calcium has not entirely eliminated the danger of foliage burning. While sufficient data have accumulated from previous investigations to warrant the conclusion that injury is caused directly by the water soluble arsenic present on the sprayed leaf surface, the processes which bring about the decomposition of the comparatively insoluble acid-lead arsenate of the spray mixture into more soluble forms, when applied on the leaf, are as yet not well understood. Especially the role that meteorological conditions play in this process has puzzled many researchers. Nevertheless, the prevailing conception among investigators in this field seems to be that arsenical burning is much more pronounced under prolonged humid conditions, high temperature, and intense sunlight than when these factors are low. Whether humidity, temperature and sunlight, singly or combined, are of any significance in increasing the actual quantity of soluble arsenic, either in form of free arsenic acid or of water soluble arsenic salts, has not been definitely proved.

In view of these uncertainties, it was thought that more definite knowledge of the chemical processes involved would be of practical value in our present attempt to solve the problem of arsenical injury to plants. The investigations herein reported were, therefore, undertaken with the purpose of studying the effect of humidity, temperature, and light on the decomposition of acid-lead-arsenate ($PbHAsO_4$) mixed with lime, sulfur, and Kayso in proportions corresponding to the 4–8–50 formula of the sulfur-lime dry mix.

Review of Literature

Recent results obtained by Haenseler and Martin (6) at the New Jersey Station have definitely shown that twig-cankers and foliage burning on peach trees are caused by the arsenate of lead present in the sulfur-lime dry mix. Trees sprayed with mixtures from which lead arsenate was omitted did not show the least trace of injury. Of course, no arsenic salt will penetrate the leaf tissue unless it is in solution, hence the lead arsenate must have decomposed on the leaf surface with a partial liberation of soluble arsenic.

That arsenic in solution causes foliage burning has been definitely shown by Kilgor (8), Clinton and Britton (2), and Sanders (16). The last author also states that lead arsenate, when used alone, was harmless to foliage, but combined with lime-sulfur it burned foliage because of the liberation of soluble arsenic. Smith (17) concludes that the toxicity of arsenicals to plants depends largely on the percentage of water soluble arsenic initially present in the spray mixture or formed on the leaf surface.

The influence of atmospheric conditions on arsenical burning was observed long before lead-arsenate was known. Gillet (5) reports that heavy dews and direct sun light increased the damage that arsenates produced on foliage. Leaves heavily dusted with Paris Green and London-Purple were not injured when kept dry, but when moistened daily they were injured severely in sun light and only slightly when kept in the shade. Haywood and McDonnel (7) found that injury to foliage and fruit of peach trees occurred only when spraying with lead-arsenate was followed by hot, clear days. No injury occurred in cold or cloudy weather. Volck (21) ascribes the severe burning, so often observed in the Pajara Valley, to the prevalence of heavy fogs and dew during the growing season.

Stewart (18) suggests high temperatures and other weather conditions as causes of arsenical burning. Lovett (10) exposed Navy bean plants sprayed with arsenicals to direct sun light and reduced sun light and observed serious burning on the former and only slight injury on the latter. On the other hand, Swingle, Morris, and Burke (20) conclude that light is not a factor in arsenical injury to foliage. Tomato plants sprayed with calcium arsenate were equally injured whether kept in the dark or exposed to sun light. They further report that high temperature increased burning slightly, while humidity proved to be the greatest environmental factor in determining arsenical injury to foliage.

Results from ten years experiments carried out by Fernald and Bourne (4) have shown that foliage injury from the use of arsenates is due to certain combinations of humidity, temperature, and light. The authors have also established certain limits of temperature and humidity within which spraying with lead arsenate seems to be entirely safe. This limit of safety varies, however, with different plants, peach trees being the most susceptible and pears the least. They suggest two possible explanations for this phenomenon. First, that lead arsenate may be more readily decomposed under certain atmospheric conditions than under others, liberating water soluble arsenic.

Second, that the leaf may differ in its physiological activities under different conditions of light, temperature and humidity and under some of these conditions is susceptible to influences not effective underothers.

Methods

The entire investigation consists of two series of experiments. The first series was carried out in the laboratory, while the second series was transferred to the open where direct sun light could be obtained. Two extremes in each one of the three meteorological factors involved, corresponding generally to the minimum and maximum conditions met with in the field during the growing season, were selected, namely: dry and moisture-saturated atmosphere; bright light and total darkness; and 80° and 110° F. In order to proximate field conditions, where the spray material remains on the leaf surface as a thin film, the sulfur-lime-arsenic mixture was spread in thin layers on glass plates and exposed to the desired atmospheric conditions for eight days. At the end of this period the amounts of water-soluble arsenic formed on the plates were quantitatively determined. On account of this it became necessary to use equal amounts of lead arsenate on each plate so that the chemical analyses should be comparable.

Preliminary tests have shown that spraying with a hand atomizer for an equal number of seconds did not give uniform results, because it was impossible to deposit in this manner equal amounts of lead arsenate on each plate. The following method was, therefore, adopted. Weighed quantities of sulfur-lime-Kayso mixture, and accurately weighed samples of lead arsenate were transferred to the glass plates. The ingredients were thoroughly mixed, made into a paste with distilled water and spread evenly over a marked area on the plate. The chemicals and the amount of water were exactly in the same proportion as ordinarily present in the 4–8–50 dry mix. Several determinations of soluble arsenic from plates thus prepared have shown that ten c.c. of spray material spread on an area of twenty square inches was about the minimum amount necessary for analysis. But in order to procure more accurate results, twice that quantity was used. It was also found that 20 cc. of the spray mixture, containing a total of 0.6644 grm. of dry material could be conveniently spread in a thin layer on an area of eighty square inches.

The glass plates used were of ten by twelve inches dimension on which an area of eight by ten inches was marked off on the unsprayed side with wax-pencil. This left a margin of two inches to prevent any loss of liquid due to possible surface run off. In order to insure uniform spread-

ing the plates were dipped before used in apple ether-extract.[2] The ether quickly evaporated, leaving a thin, uniform cover of apple wax on the surface. It was also thought that this treatment would produce conditions similar to those present on waxy foliage.

The following method was used in determining water-soluble arsenic. The material was carefully washed off from the plate into a porcelain dish by the aid of a rubber policeman, transferred to a liter pyrex flask and the volume made up to 500 c. c. with distilled water. The flasks were allowed to stand at room temperature with frequent shaking for twenty-four hours and filtered until a clear filtrate was obtained. The rest of the procedure was identically the same as that outlined in the Official Methods (11) with the exception that room temperature was used instead of 32°C. The distilled water was obtained from a Barnstead still and was freed from carbon dioxide before used.

Briefly, the procedure finally adopted consisted of mixing weighed quantities of lead arsenate and sulfur-lime-Kayso mixture, equivalent to the amounts present in 20 cc. spray, on the glass plate and making it into a paste by gradually adding 20 c.c. of distilled water. This mixture was then evenly distributed until it covered an area of 80 square inches on the glass plate.

For the first series of experiments the plates were placed in electric ovens adjusted with thermostats to control temperatures. Where light was required, artificial daylight was introduced from 100 Watt Mazda lamps, placed on the outside of the inner glass door of the oven. When dry atmosphere was desired, shallow dishes filled with fresh $CaCl_2$ were placed in the oven and changed every day. In order to maintain an atmosphere saturated with moisture a large pan of water was placed on the bottom of the oven into which strips of cheesecloth, hanging down from a perforated plate near the roof of the oven and extending along the sides, were immersed. In this manner the atmosphere was kept saturated to the dew point as was indicated by drops and streams of water collecting on the side of the oven.

For the second series of experiments an open lot near the greenhouse, where sun light had full access throughout the day, was selected. Four plates were exposed to direct sun light under the prevailing temperature, two of which were kept dry, while the other two were kept moist by spraying gently with distilled water every thirty minutes or as soon as

[2]The apple extract was prepared by Professor Hamilton as follows: 500 gm. of dried apple peelings were extracted for about eight hours with 500 c.c. of petroleum ether by means of a continuous extraction apparatus. This mixture was then diluted 1:2 with ether.

they became dry. For this purpose some of the plates were perforated in the center and fastened in a horizontal position to wooden sticks extending four feet above the ground.

In order to test the combined effects of sun light, moisture and high temperature, the following apparatus was improvised. A wooden box, without a top cover, about one foot deep and large enough to hold two glass plates, was elevated to about four feet from the ground. A thermostat was then installed and connected up with electric wires from the greenhouse. The glass plates were lowered into the box and tightly fitted in at half an inch from the top of the box on wooden planks, extending from the inside. In this manner the box was made practically air-tight so that it was possible to maintain constant temperature. By means of the thermostat and electric lamps, the temperature within the box was kept at 110°F. There being no other outlet for the heat into the surrounding atmosphere except by conduction, it was naturally absorbed by the glass plates and transmitted to the spray material closely adhering to its surface. In this manner the plates were submitted simultaneously to high temperature and direct sun light. As in the previous case, one of the plates was kept dry, while the other one was kept moist by atomizing it with distilled water. While spraying, the dry plate was covered to prevent any mist from settling on it. Since the apparatus could only hold two plates at the time, this part of the experiment was run twice in order to obtain duplicate results.

By these methods, various combinations of the three atmospheric factors studied were achieved. Thus, all plates received equal amounts of direct sun light and temperature ordinarily prevailing outside. Two plates received additional heat to raise the temperature to 110°F. Two plates were kept saturated with moisture at ordinary temperature, while two others received the highest extreme of the three factors studied. They were kept saturated with moisture at 110°F. and exposed to direct sun light.

The experiments of this series were carried out during July and the early part of August, when warm and sunny days prevailed. All plates were exposed to the open for eight days (rainy or extremely cloudy days not counted) from early morning until sunset and transferred to the greenhouse over night.

Experimental

Averages of duplicate analyses from each plate are presented in the tables, the percentage of water-soluble arsenic being based on the quantity of $PbHAsO_4$ present in the sample of dry-mix used and calcu-

lated as As_2O_5. The checks in each case consisted of 0.5932 gm. sulfur-lime-Kayso mixture and 0.0712 gm. acid lead arsenate shaken for 24 hours in 500 c.c. of distilled water.

TABLE 1. AMOUNTS OF WATER SOLUBLE ARSENIC FOUND ON PLATES COVERED WITH SPRAY MIXTURE AND KEPT FOR 8 DAYS IN ELECTRIC OVENS UNDER VARYING CONDITIONS OF HUMIDITY, LIGHT AND TEMPERATURE.

Plate No.	Treatment	As_2O_5%		
		1	2	Average
1, 2	80°F. Moisture, light	6.21	5.93	6.07
3, 4	80°F. Moisture, dark	6.30	6.02	6.16
5, 6	80°F. Dry, light	6.32	5.91	6.13
7, 8	80°F. Dry, dark	6.32	5.60	5.96
9, 10	110°F. Moisture, light	6.20	6.31	6.26
11, 12	110°F. Moisture, dark	6.02	6.36	6.19
13, 14	110°F. Dry, light	5.87	6.18	6.00
15, 16	110°F. Dry, dark	6.12	6.36	6.24
17, 18	Room temperature for 24 hrs.	5.72	5.96	5.84
19, 20 (Check)	0.6644 gm. of spray mixture shaken for 24 hours in 500 c.c. distilled water	3.58	3.80	3.69
Check	0.0712 gm. $PbHAsO_4$ shaken for 24 hours in 500 c.c. distilled water	0.82	0.90	0.86

The results from the first series of experiments, presented in Table 1, do not reveal any appreciable differences in the amounts of water-soluble arsenic found on the glass plates which could be directly attributed to any one of the three atmospheric factors studied or to any one of their combinations, when artificial light was used. On the other hand, it appears that by merely spreading the spray material in a thin layer on a large surface and exposing it to the atmosphere, considerably higher amounts of water-soluble arsenic are formed than in the checks. Furthermore, no differences were found in the amount of soluble As_2O_5 obtained from plates kept only for 24 hours at room temperature and those exposed for eight days to various combinations of temperature, humidity and light, as may be seen by comparing the results from plate Nos. 17 and 18 with those from the other plates. This is of significance because it indicates that a comparatively short time is required for the chemical reactions, which liberate soluble arsenic in this mixture, to reach equilibrium.

These results were rather contrary to expectations, since they have shown that neither temperature, humidity, nor light have exerted any influence whatever on the decomposition of acid-lead-arsenate. It was at first thought that laboratory conditions, especially the artificial light employed, might have prevented certain changes in the spray

material to take place, which would have occurred in the field. It was also thought that the violet rays, which were incidentally excluded from the experiment when "the artificial day light" was diffused through the inner glass door of the electric oven, may play a decisive part in the chemical reactions taking place between the lead arsenate and lime-sulfur. For these reasons the experiments were repeated in the open, where direct sun light could be obtained.

TABLE 2.—AMOUNT OF WATER SOLUBLE ARSENIC FOUND ON PLATES COVERED WITH SPRAY MIXTURES AND EXPOSED TO DIRECT SUN LIGHT UNDER VARYING CONDITIONS OF MOISTURE AND TEMPERATURE.

Plate No.	Treatments	As_2O_3%		
		1	2	Average
21, 22	Sun, dry, ordinary temperature	6.58	6.62	6.60
23, 24	Sun, moist, ordinary temperature	6.40	6.78	6.54
25, 26	Sun, dry, 110°F.	6.49	6.73	6.61
27, 28	Sun, moist, 110°F.	6.24	6.72	6.48

A comparison of the results from the second series of experiments presented in Table 2 shows again no significant variations in the percentages of soluble-arsenic found on the different plates. On the whole, however, the results from the field experiments were slightly higher, irrespective of the treatments, than those from the laboratory experiments. Whether this could be ascribed to the effect of sun light or to a greater absorption of CO_2, the author is not ready to say. The results of the next set of experiments, however, point unmistakingly to the latter as the cause of it and is discussed in detail later in this paper.

Thus the results of both experiments have shown that when the sulfur-lime spray, containing acid-lead-arsenate, is spread in thin layers on glass surfaces large amounts of water-soluble arsenic are formed. Naturally the question arose as to the agent responsible for this occurrence. Under ordinary atmospheric conditions $Ca(OH)_2$ is rapidly converted into $CaCO_3$ in the presence of CO_2 and moisture. Of course, spreading the liquid mixture in thin layers on large surfaces creates ideal conditions for this reaction to take place, since CO_2 will be rapidly absorbed and the solution will soon become saturated with it. Under these conditions, all of the $Ca(OH)_2$ in soluble form may become carbonated.

It was, therefore, thought that the $CaCO_3$ reacts with the $PbHAsO_4$ more readily than the $Ca(OH)_2$ and is responsible for the high percentages of water-soluble arsenic found. This, however, was only a supposition and in order to prove its validity the experiment was again repeated, using $CaCO_3$ instead of $Ca(OH)_2$. For this purpose the

lime-sulfur-dry-mix was prepared exactly in the same manner as in the previous experiment, with the exception that calcium carbonate was substituted for the hydrated lime in equal amounts. Glass plates were prepared, as previously described, and exposed for eight days to different combinations of atmospheric conditions.

TABLE 3.—AMOUNTS OF WATER SOLUBLE ARSENIC FOUND ON PLATES COVERED WITH SPRAY MIXTURE IN WHICH $Ca(OH)_2$ WAS REPLACED BY $CaCO_3$ AND KEPT FOR 8 DAYS UNDER DIFFERENT ATMOSPHERIC CONDITIONS.

Plate No.	Treatment	As_2O_5%		
		1	2	Average
29, 30	110°F., Sun, dry	8.11	8.20	8.17
31, 32	110°F., Sun, moist	8.30	8.18	8.24
33, 34	110°F., Dark, dry	8.10	8.37	8.24
35, 36	110°F., Dark, moist	8.26	8.55	8.41
Check	0.6644 gm. spray mixture shaken for 24 hours in 500 c.c. distilled water	8.31	7.85	8.08

The results of this experiment, presented in Table 3, show that considerably higher amounts of water-soluble arsenic were found when $CaCO_3$ was used than those obtained with $Ca(OH)_2$. Furthermore, the reaction was evidently not influenced at all by the process of spreading as was the case in the previous experiments. As much soluble arsenic was formed by merely shaking the spray mixture (check) for 24 hours in distilled water as by exposing it on plates to direct sun light, under 110° F. and keeping it saturated with moisture. The percentages of soluble As_2O_5 were 8.08 and 8.24 for the two treatments respectively. These results proved conclusively that the calcium carbonate formed in the mixture was responsible for the chemical reaction which resulted in the formation of large quantities of water-soluble-arsenic in the first two series of the experiments.

Another interesting phenomenon observed in this last experiment was that the brown color, due to the formation of insoluble lead sulfide, which invariably occurred when arsenate of lead was mixed with lime-sulfur and allowed to stand for 24 hours or more, did not appear when $CaCO_3$ was used. Evidently lead sulfide is not formed with calcium carbonate but instead lead carbonate and calcium acid arsenate are produced as suggested by the following equations.

$$PbHAsO_4 + CaCO_3 = PbCO_3 + CaHAsO_4.$$

The $CaHAsO_4$ is unstable and produces soluble arsenic (9.15). Of course, in the presence of large amounts of unchanged $Ca(OH)_2$ the more stable $Ca_3(AsO_4)_2$ will be formed (1) with little or no increase in soluble arsenic.

These results are in partial agreement with those obtained by Robinson (15), Patten and O'Meara (14), Campbell (1), and Mogendorff (12). The above authors found that CO_2 is an important factor in forming large amounts of soluble arsenic when the arsenates of calcium are used or when acid lead arsenate is mixed with hydrated lime. They are of the opinion that the $Ca_3(AsO_4)_2$, when applied directly or when present as a result of the interaction between $PbHAsO_4$ and $Ca(OH)_2$, is decomposed by carbonic acid or by calcium bicarbonate and the soluble salt of calcium acid arsenate and arsenic acid are produced. The investigations reported here indicate that the $PbHAsO_4$ is directly acted upon when the hydrated lime absorbs Co_2 and is converted into $CaCO_3$ which may result in the formation of soluble calcium acid arsenate.

Discussion

The results from these investigations have definitely shown that high humidity, sunlight and high temperature play no role in the formation of water soluble arsenic from $PbHAsO_4$ in sulfur-lime mixture. The question, however, still remains why foliage burning is more severe under these atmospheric factors. Accepting the theory that soluble arsenic is the agent responsible for the burning, these results point directly to physiological factors rather than to chemical agents as being responsible for excessive burning. In other words, temperature, humidity, and sun light may increase foliage burning, not by influencing the chemical reactions taking place in the spray mixture, but indirectly by increasing the permeability or by reducing the resistance of the plant to soluble arsenic present on the leaf surface. That the permeability and absorbing powers of living protoplasmic tissue are affected by environmental conditions, and especially by the very meteorologic factors studied in these experiments, has been definitely proven (13, 19). High temperature increases the rate of diffusion of dissolved substances through the protoplasmic membrane and would, naturally, result in high absorption of soluble-arsenic through the stomata and lenticels, or cuticle. Furthermore, a long period of high temperature will reduce the turgidity of the plant tissue, due to excessive transpiration, and weaken its resistance to penetration of poisonous substances. The effects of high humidity will also result in increased permeability to toxic substances. It is generally observed that under prolonged humid conditions, the internodes are long, leaf blades extensive and covered with a thin cuticle. All these characteristics would result in low resistance of the plant to the penetration of toxic substances.

On the basis of these well known facts in plant physiology it seems only logical to assume that changes in the permeability of the protoplasmic membranes should regulate the rate of penetration of water soluble arsenic into the plant tissue. Furthermore, this assumption is well substantiated by facts observed in the field. It explains why healthy and vigorous plants (6, 10) are not so much susceptible to arsenical burning as diseased or poorly developed plants are; why young (22) immature leaves are more readily burned than mature foliage. Diseased, or impaired plant tissues do not possess as great a resisting power to the penetration of soluble arsenic than a young and vigorous plant, and will, therefore, sustain greater injury. It also explains why certain species (4, 6, 20) or even varieties of plants are more susceptible to arsenical burning than others. One would, naturally, expect that when the plant can only offer weak resistance to the penetration of soluble arsenic, either by virtue of inherent characteristics, or as a result of environmental factors, it should become highly susceptible to arsenical injury.

It appears, therefore, from these results that the role which atmospheric conditions play in arsenical injury to foliage is primarily a problem of plant physiology and specifically of changes in plant permeability, rather than of pure chemistry. Further experiments, however, on the permeability of plants to soluble arsenic, under different climatic conditions, are necessary in order to definitely establish the truth of this assumption.

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Summary and Conclusions

This paper presents a study on the influence of light, temperature and humidity on the formation of water-soluble arsenic from $PbHAsO_4$ in the sulfur-lime dry-mix.

Weighed quantities of the spray mixture were spread on large glass plates, exposed for eight days to different atmospheric conditions and the water-soluble As_2O_5 determined. Two extremes in each of the three factors studied were adopted, namely; 80° and 110°F; complete darkness and bright sunlight; dry and moisture-saturated air. Both laboratory and field experiments were carried out.

1. The results from these investigations indicate that neither sun light, nor high humidity, nor a temperature of 110° F., singly or combined, play any role in directly increasing the amount of water-soluble arsenic formed in the spray mixture.

2. Large amounts of water soluble arsenic are liberated when the spray mixture is exposed in thin layers to the atmosphere, due to the formation of $CaCO_3$.

3. Still larger amounts of water-soluble arsenic are produced when hydrated lime is entirely replaced by $CaCO_3$.

4. In the presence of $CaCO_3$, the sulfur evidently remains unchanged and no PbS is formed.

5. The results reported suggest that high humidity, intense sun light, and high temperature may increase arsenical burning on foliage indirectly by affecting the permeability and absorbing power of the plant tissue for water soluble arsenic.

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SODIUM FLUOSILICATE AS A CONTROL FOR BLISTER BEETLES ON SOYBEANS IN SOUTHWESTERN LOUISIANA

By J. W. INGRAM, *Junior Entomologist, Southern Field Crop Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

In experiments conducted in Southwestern Louisiana for the control of blister beetles on soybeans, calcium arsenate and Paris green were tried both as dusts and sprays with and without lime. These acted as repellents, giving no control. Dusting with sodium cyanide gave a very small percentage of control. Various contact insecticides were tried without success. Attraction to artificial light was small. In June 1925 applications of sodium fluosilicate (analyzed as sodium fluosilicate 97.90 to 98.10 by Bureau of Chemistry, U. S. D. A.) applied at the rate of 15 pounds per acre gave practically 100 per cent control. A mixture of equal parts by volume of sodium fluosilicate and hydrated lime gave practically the same results but did not kill so quickly as undiluted sodium fluosilicate.

Soybeans are being grown on a large scale in rotation with rice in the southwestern part of Louisiana. This industry was started a number of years ago by the Rice Experiment Station, and the acreage planted has been steadily increasing. The greatest drawback to the successful growing of soybeans has been the depredations of the striped blister beetle (*Epicauta lemniscata* Fab.). This insect has been present every season for years in nearly all of the soybean fields in this section. Several times a year the beetles invade the fields and by their ravenous feeding

completely defoliate the plants. Upon first entering a field they feed close together, moving in a body over it. At times they are so numerous that the leaves and branches of the plants are completely covered. If the field is a large one the plants first fed upon will have put out new leaves before the beetles have completely gone over it. Only in the case of very small plants are the soybeans actually killed, but the growth of the defoliated plants is checked. Some fields of soybeans were abandoned last year because of blister beetle injury, and some farmers have stopped planting soybeans because of it.

The methods of control used in this section have heretofore consisted in driving the beetles into piles of straw and burning them, or herding them together in the row or in a trench, spraying oil on them, and then burning. These methods have proved unsatisfactory because they require a large amount of labor, expose the plants to injury, and fail to destroy all of the beetles.

In 1923 and 1924 an attempt was made to find a more satisfactory method of controling the pest. Calcium arsenate and Paris green were tried, both as dusts, and as sprays, with and without the addition of lime. In all cases these acted as repellents, the blister beetle refusing to eat the treated bean foliage. Unsuccessful attempts were then made to find some substance, notably sirup, which the beetles would eat when mixed with a poison and sprayed on the plants, but with no success. Various combinations for mashes were tested. One containing rice bran, sirup, and Paris green was fed upon by the beetles and death resulted, but its use was decided to be impracticable because it did not attract the beetles from the bean plants. Dusting with calcium cyanide was also tried under various conditions, and though the mortality resulting from its use appeared to be as high as 60 per cent soon after dusting, all but about 5 per cent of the beetles later revived. Various contact insecticides were used but without success. Lights were run in the field, but only a small number of the beetles were attracted to them.

On June 22, 1925, sodium fluosilicate dust[1] was first tried as a control, and a mortality of almost 100 per cent resulted. Ten fields were dusted during the months of June and July, and in every field practically all of the beetles were killed. To check the results plants on one side of an infested area were dusted with sodium fluosilicate and those on the other side were left untreated, in a number of fields. Large

[1]Samples of the insecticide used were submitted to the Bureau of Chemistry, U. S. D. A., and analyzed as sodium fluosilicate 97.90% to 98.10%.

numbers of beetles were found dead on the dusted side whereas they continued to feed on the untreated side. Owing to the fact that they were continually disturbed, the two lots became scattered and some dead were found among those which had not been dusted. Only a small number of beetles left the fields. The dusting was done with hand guns of three different types, and equally good results were obtained from each. Though some of the soybean fields covered over fifty acres, in only a few fields was it necessary to dust more than an acre in order to cover all of the beetles present. The beetles had been in most of these fields for some time prior to dusting and had become somewhat scattered. During the latter part of August and in September the beetles were more scattered when they appeared in the field than earlier in the season. The sodium fluosilicate dust was applied at the rate of about 15 pounds per acre.

In July dusting with sodium fluosilicate was begun by farmers, and a control resulted in all fields that were examined after dusting. Only favorable reports were received from fields in which the results were not checked. Experiments were conducted with a mixture of equal parts by volume of sodium fluosilicate and hydrated lime. A lighter, drier dust resulted, and in seven fields practically as good results were obtained from its use as from sodium fluosilicate alone, but the length of time before the death of the insect was generally longer.

Fields were dusted early in the morning while the dew was on the plants and at various hours of the day but no difference was observed in the mortality rate of the beetles or in the length of time before death occurred. It is apparent that the beetles should be dusted when they first enter a field because at that time they are concentrated in a relatively small area. Later they scatter out over a larger area, necessitating the use of a greater quantity of dust to kill the same number of beetles.

Immediately following dusting the majority of the beetles stop feeding. Within about four hours no beetles can be found eating, although many of them remain on the soybean plants. The first beetles die about three hours after dusting; within 24 hours the majority have died, and within 48 hours the mortality has reached 99 per cent. A few beetles may live a day longer in the soil, but very few if any are observed in the field after the third day, following an efficient dusting. Late in the season when the soybean plants are larger and the leaves have been shed some beetles may escape from the dusted area without coming in contact with the poison.

Following dusting many of the beetles hide in the soil unless it is smoothly packed, and later large numbers of dead beetles may be found

by turning up clods and loose soil in the dusted areas. Some of the beetles when disturbed by dusting leave the treated area and as a result dead beetles in numbers have been found as far as 75 yards from the place where they were dusted.

In none of the fields treated with sodium fluosilicate alone has burning of the foliage resulted. The plants were frequently dusted while the dew was on them and twice a slight rain followed the dusting, but no burning occurred. Severe burning of the foliage resulted, however, from dusting with sodium fluosilicate mixed with one-tenth its volume of Paris green, and slight burning from dusting with a mixture of sodium fluosilicate and calcium arsenate. As far as destruction of the beetles was concerned, however, equally good results were obtained with these mixtures as with sodium fluosilicate alone.

Experiments were conducted to determine how the poison kills the beetle. Earthenware jars were filled with soil and covered with screen cages. Ten beetles were placed in each jar. A summary of the experiments in which sodium fluosilicate alone was used, follows.

Experiment No.	Material in jar	Treatment of beetle	Mortality in 24 hrs.	Mortality in 48 hrs.
1	Clean soil	Dusted	10	10
2	Clean soil	Untreated	0	0
3	Clean soybean plant in clean soil	Dusted	10	10
4	Dusted soybean plant	Untreated	8	10
5	Clean soybean plant in clean soil	Untreated	0	0

A summary of the experiments in which a mixture of equal parts by volume of sodium fluosilicate and hydrated lime were used is given below:

Experiment No.	Material in jar	Treatment of beetle	Mortality in 24 hrs.	Mortality in 48 hrs.	Mortality in 72 hrs.
1	Clean soil	Dusted	9	10	10
2	Clean soil	Untreated	0	0	3
3	Clean soybean plant in clean soil	Dusted	9	10	10
4	Dusted soybean plant	Untreated	4	7	9
5	Clean soybean plant in clean soil	Untreated	1	1	1
6	Dusted soil	Untreated	1	6	7

In experiment No. 4 the bean leaves were not eaten by the beetles, thus it is apparent that death resulted from the beetle getting the poison into its digestive system, either through its mouth parts during

dusting or by the dusted beetle raking its irritated tarsi through its mouth parts and not by its eating poisoned foliage. Blister beetles normally have the habit of passing the tarsi through the mouth, probably more for the purpose of cleaning the mouth parts than the tarsi.

A series of experiments was conducted to determine whether the death of the beetle results in any manner other than by the poison entering the alimentary tract. It was thought that sodium fluosilicate might kill the insect by penetrating the external chitin or chitinous lining of the trachae and reacting upon the internal tissues.[2]

With the exception of lot No. 1 the beetles were treated in lots of ten each. Each lot was placed in a glass partly filled with moist sand. A small brush was used in dusting. The results of the experiments conducted on different dates follow.

Lot No.	Treatment	Mortality in 24 hrs.	48 hrs.
1 (5 beetles)	Head dusted (primarily to dust mouthparts)	5	5
2		6	8
3		4	6
4		9	10
5		6	8
1 (5 beetles)	Abdomen dusted (ventral side and wing covers)	2	2
2		2	2
3		5	5
4		2	2
1 (5 beetles)	Entire beetle dusted	5	5
2		9	9
1 (5 beetles)	Control	0	0
2		0	2
3		0	1
4		0	1
5		0	0

The mortality after 48 hours is not recorded since the beetles in the control glasses began to die in numbers after this time. Owing to their efforts to escape from the glasses the confined beetles appeared to notice the irritating effect of the poison less than they had in the field, and they did not try to clean themselves so much. This is probably the reason why the mortality in some cases was no greater. When only the abdomen was dusted some of the beetles raked the rear pair of feet over it in an attempt to free themselves of the irritating dust, and it is probable that the dust was carried to the mouth from the abdomen by the feet. Death may possibly have resulted from the effect of the poison

[2]Shafer in Michigan Bulletin No. 11 advanced the theory that borax and sodium fluoride are possibly capable of such action.

on the tissues of the entire body, but it appears probable that it resulted mainly if not altogether from the beetle's getting poison into its digestive tract.

Sodium fluosilicate (Na_2SiF_6) is a white powder. It occurs as a by-product in the manufacture of acid phosphate. When phosphate rock is treated with sulphuric acid, hydrofluosilicic acid is produced. When sodium chloride is added, sodium fluosilicate is precipitated. Per unit of volume sodium fluosilicate was found to be 2 5/8 times as heavy as calcium arsenate. A slight irritation of the nasal passages and the mouth results from breathing sodium fluosilicate dust, but within two or three hours after dusting this sensation passes away. All of the sodium fluosilicate used in this section was guaranteed by the manufacturers to be 99 per cent pure. The cost was ten cents per pound f. o. b. at the shipping point.

Over a thousand pounds of sodium fluosilicate were used in controlling the blister beetle in the rice-growing section of southwestern Louisiana this year, and it appears that this poison will be generally used in controlling the beetle in this section in 1926.

DETERMINING THE EFFECTIVENESS OF DORMANT TREATMENTS AGAINST THE SAN JOSE SCALE

By W. S. ABBOTT, *Bureau of Entomology*

ABSTRACT

Attention is called to the fact that a count of the first-generation San Jose scales, *Aspidiotus perniciosus* Comst., settling on the new wood furnishes a reliable index of the effect of the dormant treatment and also a check on the accuracy of the count of dead and living scales. A very pronounced negative correlation is shown between the per cent of dead scales and the average number of young scales per inch of new wood. This correlation is considered to indicate that in the experiments reported, the counts made 30 days after the application of the dormant spray gave reliable results.

Two articles have recently appeared in the JOURNAL of ECONOMIC ENTOMOLOGY in which the question was raised as to how much time should elapse between the application of a dormant spray for the control of the San Jose scale and the making of counts to determine its effectiveness, and the figures given would indicate that a period of 30 days was not sufficient. As this is a very important point it may be of interest to call attention to an additional method of determining the effectiveness of dormant sprays that has been used by the entomologists of the Federal Insecticide and Fungicide Board.

For this purpose a count of the number of young scales of the first generation that settle on the new wood is made in addition to the usual count of dead and living scales made about 30 days after the dormant treatment.[1]

Since the average number of young scales per inch of new wood obviously depends on the number of parent females surviving the treatment, this figure furnishes an excellent check on the counts of hibernating scales.

Since the *actual* size of the first generation may be greatly influenced by factors other than the number of female scales that survive, as, for example, initial infestation or climatic conditions, this count, taken by itself, means very little, but compared with other counts it is of great value in showing the relative effectiveness of various treatments or dilutions.

In order to determine just how closely these two sets of figures are related, and to check the accuracy of the 30 day counts, correlation coefficients for the per cent dead, as determined by a count of 2,000 scales made one month after treatment, and the average number of young scales per inch of new wood, have been computed. These correlation coefficients for certain typical sets of experiments with dry lime sulphurs are given in Table 1. It is realized that such coefficients, where only three experiments are used, are of very doubtful value; but since they fall within the range covered when six or nine tests are used, they have been included as at least indicative.

TABLE 1.—CORRELATION COEFFICIENTS FOR PER CENT OF FEMALE SAN JOSE SCALES DEAD ONE MONTH AFTER TREATMENT AND THE AVERAGE NUMBER OF FIRST-GENERATION SCALES PER INCH OF NEW WOOD.

Date	Number of experiments	Coefficient of correlation for per cent dead with average young scales per inch of new wood
1922	3	$-.933 \pm .051$
1922	3	$-.859 \pm .141$
1922	3	$-.957 \pm .033$
1923	6	$-.904 \pm .050$
1923	6	$-.814 \pm .093$
1922	9	$-.955 \pm .019$
1922	9	$-.876 \pm .052$

It is considered that the coefficients shown above are high enough to warrant the conclusion that the original figures are as accurate as can be reasonably expected from routine field experiments. They also

[1]For a detailed account of the methods used see U. S. Dept. of Agr. Bulletin 1371, pages 5 and 6.

indicate that the counts of the first-generation scales on new wood furnish a reliable index of the effectiveness of the dormant treatments.

The counting of the first-generation scales is a comparatively simple matter, as it only involves the measuring of the twigs and the counting of all of the young scales on a given length of twig. Counting the hibernating scales is much more complicated as it includes determining whether each scale is dead or living and also whether a sufficient time has elapsed to give the maximum efficiency of the insecticide used.

As, theoretically, there should be a perfect negative correlation between these two sets of data, the reliability of the individual figures can be estimated from the correlation coefficients. That is, the nearer the coefficient approaches—1. the more reliable the original data.

Since, in these computations, the correlation is between the data for first-generation young, which should be quite accurate, and the counts of hibernating scales, which are much more likely to be inaccurate, it is reasonable to expect that any reduction in the correlation coefficient will be caused by the latter factor. As the coefficients shown in Table I are fairly high, they indicate that the counts were fairly accurate and that, in these experiments, the records taken 30 days after treatment gave the full effectiveness of the materials used.

Conclusions

A count of the first-generation young per inch of new wood furnishes a reliable index of the effectiveness of dormant treatments against the San Jose scale.

A comparison of these counts will show the relative efficiency of various treatments.

A high negative correlation between this count and the per cent of hibernating scales found dead indicates the reliability of the latter count.

The correlation coefficients shown indicate that in these experiments the records taken 30 days after treatment were accurate.

FIGHTING LOCUSTS WITH A CONTACT INSECTICIDE

By CHARLES H. GABLE, *Associate Entomologist, Cereal and Forage Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

An outbreak of one of the "bird grasshoppers," known as the larger obscure locust, (*Schistocerca obscura* (Fab.)), was reported at Pleasanton, thirty miles south of San Antonio, Texas, the latter part of June, 1925.

The distribution of this species is given by Blatchley[1] as follows: "The known range of the species extends from Baltimore, Md., south and southwest in the coastwise states to Texas and Mexico. According to Scudder it is found throughout the latter country; also in New Mexico, eastern Colorado, Nebraska and Iowa." Although this locust is closely related to the species which has been causing great losses in Mexico during the last few years, it has never before been reported as seriously injuring cultivated crops, and the outbreak may have been due to the combination of an unusually heavy infestation and an extremely dry season which stunted the growth of native food plants.

Much of Atascosa County was involved in this outbreak and serious losses occurred in many fields, chiefly of cotton. Considerable numbers of the locust were noted in a much larger territory, but they did not attack cultivated crops.

Unlike the common species of injurious grasshoppers, these locusts seldom touch the ground after they develop wings. They congregate in the tops of trees and brush along the edges of the field and fly in to feed about eight or nine o'clock in the morning. Usually they do not remain on the plants all day, but when through feeding fly back to the trees, returning when they again become hungry. There is thus almost a constant movement between the trees and the field.

Practically all the locusts in an area of several square rods will start into flight at the same time when disturbed in the field. They may again alight in the field, but often go to the brush even though it is fifty to one hundred yards away. The flock formation which they sometimes maintain much resembles that of blackbirds.

The immature forms were restricted to the brush some distance from the fields, according to reports from farmers, and did not attack the crops. The outbreak was not reported to the writer until after all the locusts had become mature, so there was no opportunity to test the effectiveness of the standard bran mash during the earlier stages. The arboreal habit of the adults is so pronounced that they do not come in

[1]Blatchley, W. S. Orthoptera of Northeastern America, p. 317, 1920.

contact with the bait on the ground or get close enough to it to be attracted, so that other means of control had to be worked out.

It was estimated that 90 per cent of the locusts left the fields at night and roosted on a strip of trees and brush fifty feet wide. This concentration was so marked that it suggested the use of a contact spray. The large size of the species and the resistance of grasshoppers in general to contact sprays indicated that a powerful insecticide would have to be used. Cattle dip seemed the most promising material available and a standard brand was secured which has the following analysis:

Total arsenic water soluble as metallic	15.14%
Actual arsenious oxide (As_2O_3)	20.02%
Water	44.40%
Equal parts soft soap and sodium cresolate	20.44%

A solution of one part dip to one hundred and forty parts water was first tried. This strength killed many of the locusts, but was not satisfactory. Those which were thoroughly wet with the solution died, but in field practice it is impossible to treat every locust thoroughly, and those partially wet or hit only with a fine mist seemed to survive. The strength was then increased to one part dip to eighty parts water, which proved to be very effective. Those which were completely covered with the liquid began to die in about twelve hours, and for several days thereafter deaths occurred.

A good barrel sprayer with twenty-five feet of hose equipped with a Bordeaux nozzle was used. The nozzle was adjusted to throw a solid stream which broke into a coarse spray at a distance, making it possible to reach the tops of the highest trees and also the entire strip of infested brush while the outfit remained in the open.

The locusts were so active and wild in the daytime, that little could be accomplished except in the early morning before sunrise. At that time they were quite sluggish, owing possibly to the temperature, and a thorough application could be made without those ahead of the sprayer becoming scattered.

The solution used is very caustic and cannot be applied to cultivated crops without serious injury. The leaves of the trees and brush were severely burned, but none of the farmers made any objection.

The burning of the mesquite trees caused them to shed their beans, which were well developed at the time, and these beans as well as all other vegetation under the trees were thoroughly covered with the solution. Stock of all kinds feed freely on mesquite beans, and a cow was pastured for a week in a lane where only sprayed vegetation and beans were available for food, in order to test the possibility of poison-

ing. Not only did the cow fail to develop any symptoms of poisoning, but the owner insisted that her condition was distinctly improved at the end of the week. Horses and mules were then turned into the same lane, and stock was present in several pastures where spraying was conducted. No complaints of poisoning were received.

The infestation of locusts congregated in the brush along one side of a sixty acre field was sufficient to completely destroy the crop. The applications of the spray were made at a cost of $5.00 for the material and a total of about four hours time for three men and a team. It was estimated that at least 85 per cent of the locusts were killed and the entire crop was saved. Eight hundred and seventy-five dead locusts were counted under one small mesquite tree. This did not represent the entire kill on that tree, however, since sand lizards, mice, and rats were present in considerable numbers and fed very freely on the dead locusts during the previous night.

The results obtained were very satisfactory, both to those making the experiments and to the farmers. The method is inexpensive, effective, and requires a minimum amount of labor. Some may object to the purchase of a barrel sprayer, but in this section farmers are generally recognizing that such an outfit has many uses and is really a necessary part of their farm equipment.

AN EVAPORATION CUP USEFUL FOR CHEMOTROPIC STUDIES OF INSECTS IN THE FIELD

By ALVAH PETERSON, *Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A small evaporation cup which will hold concentrated aromatic chemicals has proven to be useful in making studies of insect chemotropism under field conditions when liquid traps are employed. Insects attracted to the chemicals in the vials fall into the water surrounding the evaporation cups. Protective covers over the vials keep out rain and spray materials.

For several years the writer has investigated problems associated with insect chemotropism. In these investigations it has been necessary to construct and make use of traps best suited to the habits of the various species studied. It has been observed that some insects, particularly small moths, may be caught on the surface of liquid baits composed largely of water. If a liquid trap is employed and one wishes to investi-

gate the response of insects to concentrated compounds, e. g., essential oils, alcohols, esters, etc., then an evaporation cup may prove to be satisfactory because it will hold liquid or solid chemicals and will float on water. Some of the advantages in the use of an evaporation cup are; the aromatic chemical placed in the vial evaporates at a fairly constant rate, the small size of the cup does not interfere with the catch, and the protective cover over the vial keeps out rain and spray materials.

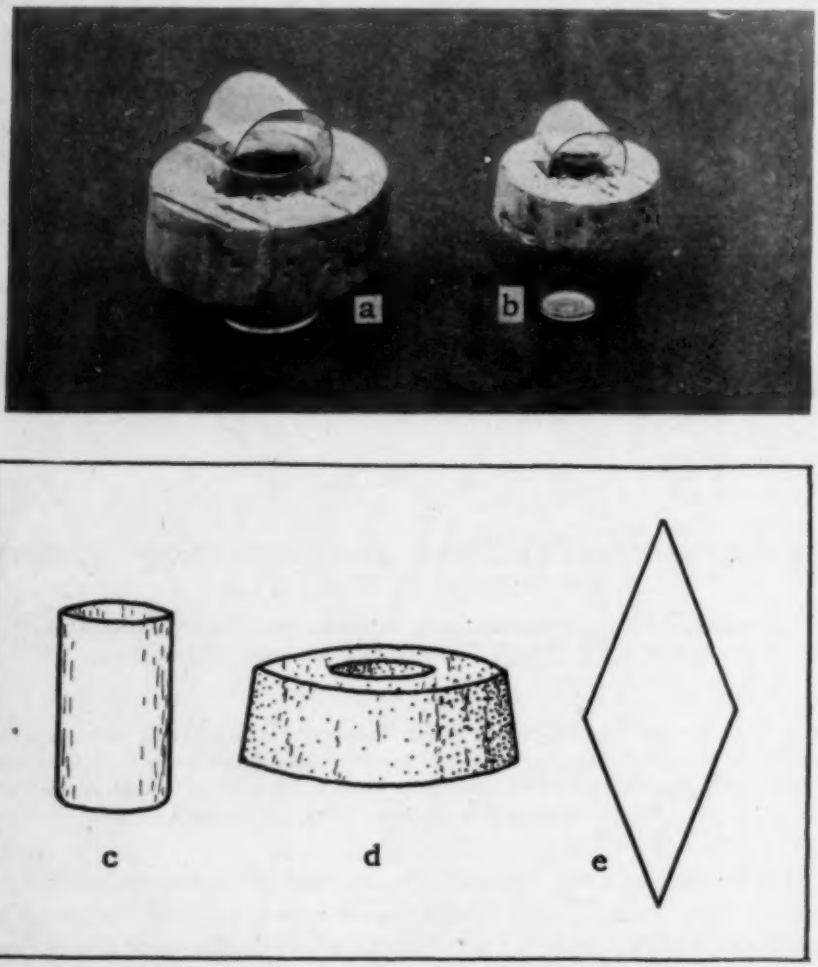


FIG. 49—Evaporation cups and parts. All figures natural size. (a) Large size evaporation cup, (b) small size evaporation cup, (c) vial of evaporation cup (a), (d) cork of evaporation cup (a), (e) celluloid or paper cover of evaporation cup (a).

An evaporation cup (Figure 49) consists of three parts; a short straight vial (c), a round flat cork (d) with a hole in the center, and a piece of celluloid or stiff paper (e) cut in the form of an elongated diamond (parallelogram). Two sizes of vials were used, a 10 x 25 mm. vial (b) with an approximate capacity of 1.5 cc. and a 15 x 25 mm. vial (a) with an approximate capacity of 3 cc. The hole in the center of the cork (d) is of such size that the vial fits snugly. The open end of the vial should project about 5 mm. above the cork. The cork must be large enough to float the evaporation cup when the vial is filled and also prevent the cup from turning over in the presence of high wind. Allowance must be made for the fact that a cork absorbs some moisture when it stands in water for a long time. This makes it less buoyant. A thin coating of paraffine on the outside of the cork will help to keep the buoyancy more constant. The writer found that a 10 x 25 mm. vial needs a round flat cork about 30 mm. wide and 10 mm. high, while a 15 x 25 mm. vial needs a cork about 35 mm. wide and 10 mm. high.

The protective cover (e) made of celluloid (10/1000 of an inch thick) or thin stiff paper, cut so it resembles an elongated diamond (parallelogram), should be of such size that the middle portion will completely cover the open end of the vial. A 10 x 25 mm. vial needs a cover whose diagonal lines measure about 12 x 40 mm., and a 15 x 25 mm. vial needs a cover that measures 20 x 50 mm. The two pointed ends of the cover are pushed between the vial and the cork on the opposite sides of the vial. The upper curved portion of the cover when in position should not be in contact with the open end of the vial (a and b); about 5 to 8 mm. away is most desirable.

The vial is most easily filled before the cover is put on completely. If the cover is in position, the vial may be filled with a dropper of some sort. In most of our experiments where evaporation cups were used they were filled at the laboratory and the covers put on at once. The evaporation cups were carried to the field on the surface of moist sand placed in some convenient container, usually a water bucket.

In the orchard the evaporation cups were floated on water in containers suspended from the branches of fruit trees, while in the open fields they were placed in containers filled with water located on stands. The most satisfactory container, serving as a liquid trap, proved to be a small enameled stew pan with a wire bail and having a capacity of three to four pints (for illustration see reference.)[1] The diameter of the open

[1]1926. Alvah Peterson. Additional information on baits attractive to the oriental peach moth, *Laspeyresia molesta* Busk. Jour. Econ. Ent. V. 19, p. 429–439.

pan at the surface of the water when almost filled approximated 20 cm. Some loss of captured insects occurs during heavy rains because the containers become full and overflow. This loss may be reduced by making a few small holes through the pan about the upper margin, 10 mm. from the top.

The odor arises from the evaporation cups and desseminates through the air. If it is attractive to insects, they will come to the pans, and in attempting to reach the source of the odor many of them will strike or fall into the water. If the wings or some portions of the body become wet, the insects will be retained in or on the liquid. The smooth steep sides of the pan keep most species from crawling out. The species of insects caught during the past season (1926) belonged to the Lepidoptera, Diptera, Hymenoptera, Coleoptera, and other orders. The following is an excellent example of the usefulness of evaporation cups. During the months of May and June, 1926, in peach and apple orchards about Riverton, New Jersey large numbers of bumble bees, *Bombus* sp., and honey bees, *Apis mellifera*, were caught in stew pans filled with water which supported evaporation cups filled with the oil of Cassia.

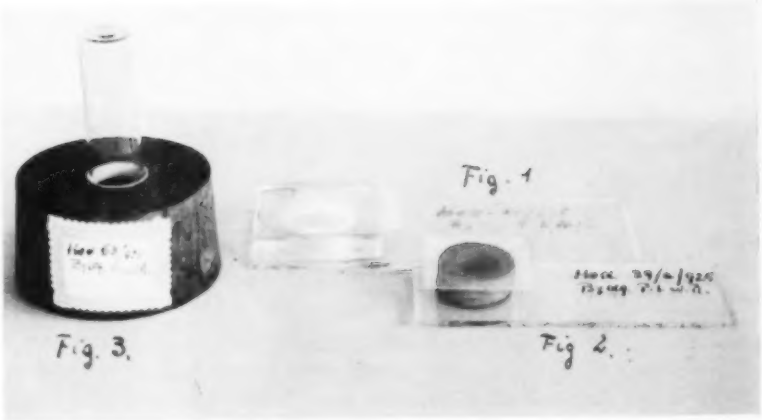
The high surface tension of ordinary water allows many individuals of small species to escape that do not strike the water with sufficient force to wet their bodies. Probably some chemical or commercial product, saponin or soap, may be used to lower the surface tension of the water and thus bring about a condition which will cause small insects, light in weight, to become more readily wet when they strike the liquid.

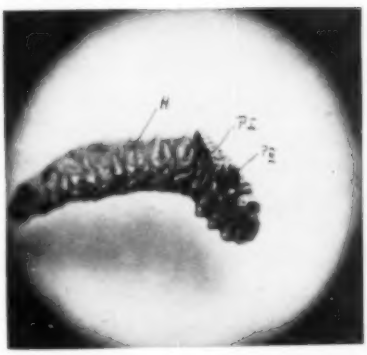
The above description and discussion of the use of evaporation cups is presented with the idea that it may be useful for investigators studying the chemotropic responses of certain species of insects under orchard and open field conditions.

A GOOD TYPE OF CAGE FOR REARING PARASITES

By S. KELER, *Bydgoszcz, Poland*

It is a well known fact that the method of study is one of the most important factors influencing the effects intended. I suppose therefore to awake some interest in economic entomologists with reporting my methods of rearing used in my laboratory during the study of the bionomics of *Pimpla nucun* Rtz. (= *calobata* Grav.?), an ectoparasite of the apple blossom weevil (*Anthonomus pomorum*).





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1-3. The three types of microcages. 1—Glass wet camera of van Tighem, 2—Cork-cell cage, 3—Glass-tube micro-cage; 4. Parasite larva feeding on its host. Photomicrograph taken directly from the cage (Fig. 1) with a binocular camera. (Black ground); 5. Hyperparasite (P II) and Parasite (P I). Photomicrograph as fig. 4. (White ground). Author's photos.

I originally supposed one could use the type of cage described and used by Packard for rearing Hessian fly parasites, but it proved to take too much time for preparing them on account of larger size of my species. The cage should be as simple as possible and should allow the manufacturing it by oneself in the laboratory. My cages, which I would call "micro-cages" represent a modified type of the micro-cages of Packard.

The first used type was a simple wet camera of van Tighem, (Pl. 11, fig. 1) of about 1 cm in diameter and about ½ cm high. The camera was pasted near the end of an ordinary microscopic glass, the rest of it has been preserved for notes. The camera was covered with a cover glass, held on its place by two or three droplets of honey, which on the other hand, kept a sufficient degree of moisture in the camera. The hanging drops of water, which I used originally to keep the camera in a certain degree of humidity proved to be not important and just dangerous to the larvae which in many cases died from the moisture covering the bottom and walls of the cell.

In another type I replaced the glass camera with a cork one, of the same diameter in tight and with about 3 mm. strong walls. In this type of cage I used the hanging drops with no damage to larvae, but the droplets of honey, as mentioned above, proved to be quite sufficient to keep the camera somewhat wet.

I was very satisfied with both types of cages, which allowed me making my observations in the transparent and reflected light any time without disturbing the parasite in its functions. There is no difficulty in studying the parasite with a lens, a binocular or a microscope. All of my photomicrographs, made with a binocular camera *in vivo* met with no difficulties.

The third type of cage is very simple (Pl. 11, fig. 3) and convenient in general use, but the possibility of observations is limited as it excludes the observations in transparent light which is especially important during the prepupal and pupal stages in cocoons. Besides that, the removal of the glass tube is impossible after the larva has made the cocoon lying generally in the corner of the cage connecting the walls of the tube with the cork bottom of cage.

Scientific Notes

The European Rose-gall in Colorado. Many years ago I raised some sweetbriar roses (*Rosa rubiginosa*) from seed in Boulder, Colorado. They were never attacked by the native species of *Rhodites* (*R. fusiformans* Ashm., *R. bicolor* Harris, *R. rosaefolii* Ckll., *R. variabilis* Bassett and *R. tuberculator* Ckll., all occur in the vicinity), but about 1922 the European *Rhodites rosae* (Linné) began to appear, the first galls being found by Dr. F. Ranaley in his garden on Pleasant Street. In the last two years *R. rosae* galls have been numerous on my sweetbriars, and I wondered whether they would be attacked by the Chalcidoid parasites of the native species. We bred out many such parasites from the *R. rosae*, but on referring them to Mr. A. B. Gahan in Washington, they are found to be also European forms, namely *Callimome bedeguaris* (Linné) and *Habrocytus bedeguaris* Thomson. The latter species described from Sweden, is in the collection of the U. S. National Museum from Ontario and British Columbia, as I learn from Mr. Gahan.

T. D. A. COCKERELL

Oriental Peach Moth (*Grapholitha molesta* Busck). A light infestation of this insect was recently found on young peach trees in Yonkers, New York. On several occasions during the past two seasons injury to peach twigs resembling the work of the oriental peach moth was noted, but as no larvae were located the identity of the species could not be established with certainty. A careful search was made during the season of 1926, however, with the result that four larvae taken from peach twigs on August 28th, proved to be of this species. The specimens were kindly identified by Doctor Alvah Peterson.

ALBERT HARTZELL, *Boyce Thompson Institute for Plant Research, Yonkers, New York*

Aserica castanea Arrow. An adult of this species, identified through the courtesy of Mr. Robert J. Sim, was captured by Dr. Francis O. Holmes on August 7th, in Yonkers, N. Y. Additional captures were made in the same locality by the writer on August 25th and September 7th. In one instance an adult was found at the roots of a seedling peach tree near a number of freshly laid yellowish-white eggs which apparently were deposited by this individual.

ALBERT HARTZELL, *Boyce Thompson Institute for Plant Research, Yonkers, New York*

Large Game. Fermenting liquid-baits have been used during the past two summers as attractives for the Oriental fruit moth. Large numbers of other insects, principally Noctuidae, Muscidae and certain species of Hymenoptera and Coleoptera, have also been trapped in such baits. Many, no doubt, accidentally fall in the baits but others are attracted. At present attention is called to some unusual visitors of bait-pails. A full grown Cecropia larva, a wren and three bats have been recovered on different occasions. The Cecropia larva apparently fell in by chance. It is supposed that the vertebrates were caught in attempts to rescue insects from the bait-pails or were trapped in giving chase to insects frequenting these baits.

S. W. FROST, *The Pennsylvania State College*

Cotton Hopper Control. During the present season, the cotton hopper (*Psallus seriatus* Reut.) has been a very serious pest in Alabama and for the first time noticed in this state. The damage is caused by their feeding on the very small squares as they are forming, causing them to fall, thus materially reducing the crop. With the reduction of the squares the plants assume a very rank growth, growing much taller and straighter, and the number of bolls are very few. In many cases the bottom crop, which is the heaviest producer, has been almost entirely destroyed, as well as a good portion of the middle crop.

Sulphur has been recommended by the Texas and other experiment stations and has given good results. With this in mind, S-Dusting Mixture, put out by the American Cyanamid Company, was tested. This mixture was composed of 50 per cent sulphur and 50 per cent calcium cyanide. The cyanide content was between 17 and 25 per cent. This was applied for two reasons, namely: to determine the effectiveness of the mixture for controlling the cotton hopper, and to determine whether burning of the foliage took place.

Two tests were made at different periods. During the first period the bottom crop was being set. Two plots were used in different locations. One was on the experiment station and the other on a private farm. In these tests the results were very similar. The plots and checks were given five sets of sweepings, each composed of ten short sweeps. The results are as follows:

RESULTS OF DUSTING WITH S-DUSTING MIXTURE IN CONTROLLING COTTON HOPPER. NUMBER OF ADULTS (A) AND NYMPHS (N) PER FIVE SWEEPINGS

Experiment Station Plot, Auburn, Alabama

	Dusted		Undusted	
	A.	N.	A.	N.
July 21, 1926.				
Total.....	30.0	0.0	64.0	65.0
Average.....	6.0	0.0	12.8	13.0
July 22, 1926				
Total.....	35.0	9.0	58.0	26.0
Average.....	7.0	1.8	11.6	5.2
July 24, 1926.				
Total.....	29.0	10.0	77.0	26.0
Average.....	5.8	2.0	15.4	5.2
Private Farm, Auburn, Alabama.				
July 21, 1926.				
Total.....	22.0	4.0	80.0	48.0
Average.....	4.4	0.8	16.0	9.6
July 22, 1926.				
Total.....	26.0	1.0	83.0	32.0
Average.....	5.2	0.2	16.6	6.4
July 24, 1926.				
Total.....	27.0	5.0	90.0	34.0
Average.....	5.4	1.0	18.0	6.8

Aside from the fact that the number of hoppers was materially decreased in those plots that were dusted, it was especially noticeable that the nymphs were decreased

to a greater extent, especially the first day after the dust had been applied. The amount of dust used in these tests was eight pounds per acre. No burning was noticed on any of the foliage.

To carry this experiment further and to have a check on the above results, another test was carried out on August 10. This time three plots were dusted with five, ten and twenty pounds of S-Dusting Mixture, respectively. Five check rows were allowed between each of the dusted plots. Forty-eight hours later five sets of sweepings were made on the dusted plots and ten on the undusted plots. The results are as follows:

RESULTS OF DUSTING WITH S-DUSTING MIXTURE IN CONTROLLING COTTON HOPPER

	Dusted						Undusted	
	5 lbs.		10 lbs.		20 lbs.			
	A.	N.	A.	N.	A.	N.	A.	N.
Aug. 12, 1926.								
Total.....	21.0	8.0	22.0	2.0	14.0	2.0	87.0	49.0
Average.....	4.2	1.6	4.4	0.4	2.8	0.4	8.7	4.9
Aug. 13, 1926.								
Total.....	21.0	3.0	17.0	1.0	9.0	2.0	92.0	52.0
Average.....	4.2	0.6	3.4	0.2	1.8	0.4	9.2	5.2
Aug. 14, 1926.								
Total.....	22.0	5.0	18.0	2.0	13.0	1.0	97.0	39.0
Average.....	4.4	1.0	3.6	0.4	2.6	0.2	9.7	3.9
Aug.18 , 1926.								
Total.....	25.0	14.0	24.0	9.0	17.0	5.0	101.0	54.0
Average.....	5.0	2.8	4.8	1.8	3.4	1.0	10.1	5.4

On August 11, the day after the dusting mixture was applied a rain fell. This made it undesirable to make a sweeping. The following day, however, the dust showed very effective control in materially reducing the number of adults and nymphs.[1] An even greater decrease would have probably resulted, had it not rained. Four days after the dust had been applied more individuals, both adults and nymphs, were found, the former flying from the undusted plots and the nymphs hatching from the eggs which were not killed by the dust. In almost all cases the number found after each ten sweepings was not widely variable, the totals usually running quite similar. There was, however, a greater degree of variation in the undusted plots, ranging from seven to twenty in the most extreme case. In these plots no burning was noticed even where twenty pounds per acre were used.

CONCLUSION. It has been found that S-Dusting Mixture was a good control medium for the cotton flea hopper, eight-ten pounds per acre applied once a week being the most satisfactory; and that no burning of the foliage resulted from the application of the cyanide compound.

HENRY G. GOOD, *Auburn, Ala.*

Occurence of the Oriental Peach Moth in N. Y. State. The Oriental Peach Moth, *Grapholitha molesta* Busck, has been found occurring quite generally in the peach orchards of Marlboro and Lloyd township, and Newburgh township, Orange County, N. Y. The presence of the pest has been suspected for several years but no posi-

tive identifications have ever been made. Larvae sent in July 24, 1926 were identified as species of Olethreutidae by Dr. Heinrich, of Washington, D. C., who stated they were either *G. molesta* Busck or one of the closely allied species. Later adults were reared from larvae from both twigs and fruit and were identified by Dr. W. T. M. Forbes as *Grapholitha molesta* Busck.

W. D. MILL

Chrysanthemum Midge, *Diarthronomyia hypogaea* Löw.—On a recent nursery inspection trip this insect was found infesting a greenhouse near Sterling, Colorado. This is the first and only infestation to be found in the state. Precautions have been taken to stamp out the infestation before it spreads. Available information strongly indicates that this pest was recently introduced into the state on stock shipped from eastern states. Identification was corroborated by Dr. C. A. Weigel.

GEORGE M. LIST and GEORGE S. LANGFORD,
Office of State Entomologist, Fort Collins, Colorado

Killing Mosquitoes with Cyanogas Calcium Cyanide.—A test was run at Chadbourn, N. C., September 14th, 1926, in cooperation with Mr. W. A. Thomas of the Bureau of Entomology. Mosquitoes were very abundant at night about the house and were observed to congregate in immense numbers during the day time in open sheds near by. The sheds were dusted with Cyanogas Calcium Cyanide A-Dust with an American Beauty Knapsack Duster. Time, 3:30 P. M. Temperature, 75 degrees F. Relative humidity, 96%. The air was fairly calm. Weather: Cloudy, rain appeared imminent. In fact, it began to sprinkle while the dusting was being done. The dust was directed into the corners and around the eaves of the sheds, and back of the farm implements, barrels, etc., where swarms of mosquitoes were resting. A considerable residue of dust was directed to the ground to prevent the revival of those mosquitoes which might be simply stupefied and fall from above. The entire space was filled with a fog of dust. As this effect was realized, not only mosquitoes but house flies, silver fish, harvest-men, and small moths were seen to drop to the ground. Spiders running along the residue on the ground soon succumbed, but those in webs near the eaves were not killed. Two sheets of newspaper were placed in the corner of one of the sheds before dusting and at 4:30 P. M., one hour after the dusting, were collected and carried to the laboratory for counting. The following insects were found:

165 Female Mosquitoes	5 House Flies
645 Male Mosquitoes	1 Small Dipteron
1 Small Moth	

These were kept for several days but none were seen to revive, except one of the House Flies which began to kick when taken back to the laboratory. It never fully recovered, however, although it quivered slightly the following day. It may have been that this fly had flown in after the gas was somewhat expended. The next day more mosquitoes had entered the sheds but in lessened numbers. Persistent dustings would no doubt effectively reduce the mosquito population in such places.

STANLEY W. BROMLEY

The Work of the Pickly-Pear Board in Australia. Multigraphed copies of the Sixth Annual Report of the Commonwealth Prickly-Pear Board of Australia have just reached this country. It appears that the activities of the Board's agents, especially in the southwestern United States, are beginning to show excellent results. The report is signed by Alan P. Dodd, present officer in charge of the investigations, and covers the operations of the year. It seems that seven species of Lepidoptera, seven of Coleoptera, one of Diptera, four of Heteroptera, six of Homoptera (all Dactylopius) and one arachnid (the Opuntia red-spider, *Tetranychus opuntiae*) have been introduced with varying results.

Of the Lepidoptera, *Cactoblastis cactorum*, introduced from South America, is the most promising of the internally feeding larvae yet introduced. It has shown itself perfectly adaptable, with a partiality for *Opuntia inermis*. It is undeterred by rotten pear conditions, and has large numbers of eggs. It also feeds on *Opuntia stricta* and is partial to the tiger pear (*O. aurantiaca*).

None of the Coleoptera, (which include five species of Monilima,) are especially promising; and the Dipterous seed midge, *Asphondylia opuntiae*, is promising only in certain localities.

The Heteroptera include four species of Chelinidea, and some of them are promising.

The Homoptera, all of which are species of Dactylopius (six in all) are giving very execellent results. *D. tomentosus*, coming from Texas, Arizona, California and one or two other localities, has spread rather slowly in New South Wales, but in Queensland its work on *Opuntia inermis* is very good, and Mr. Dodd thinks that the ultimate clearing of the land is only a matter of time. He prophesies complete results in central Queensland in from fifteen to twenty years. In some localities the plants are already collapsing and dying over large areas. The work of these "cochineal insects" as they are termed in the report is greatly aided by the work of the red spider and that of some of the borers. These weaken the plant so that it readily succumbs to the attacks of the species of Dactylopius.

As bright as is the outlook for very successful mealy bug work, Mr. Dodd and his fellow workers must have a feeling of decided uncertainty as to the future, from the fact that the celebrated mealy-bug ladybird, *Cryptolaemus montrousieri*, which has done such excellent work in many parts of the world against mealy-bugs injuring crop plants, is apparently a native of Queensland. Mulsant described both genus and species from specimens received from Queensland.

L. O. HOWARD

TENTH INTERNATIONAL CONGRESS OF ZOOLOGY IN BUDAPEST, 1927

PRELIMINARY ANNOUNCEMENT

The Ninth International Congress of Zoology in session at Monaco in March, 1913, decided to hold the tenth meeting in 1916 at Budapest, Hungary, under the presidency of the undersigned. Unfortunately the events of the war made it impossible to adhere to this decision, and the meeting of the Tenth Congress had to be postponed. The present international situation is now such, however, that this congress can be held during the coming year.

In accord with the Permanent Committee of the International Congress of Zoology I have the honor, therefore, to announce that the Tenth International Congress of

Zoology will meet in Budapest, Hungary, on September 4 to 9, 1927, and that all zoologists and friends of zoology are hereby cordially invited to attend.

The detailed program of the Congress will be issued before the end of the present year and sent to those interested.

Budapest, Hungarian National Museum, September 4, 1926.

Dr. G. HORVÁTH,
President, Tenth International Congress of Zoology,
Director, Department of Zoology,
Hungarian National Museum

THE ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The Fourth Rocky Mountain Conference of Entomologists was held in Pingree Park, Colorado, August 16 to 21, inclusive. Good weather and a very representative crowd favored what was reported to be the most pleasant and profitable meeting we have yet held. There was a total registration at the camp for the week of 62, representing 13 states, and following is a list of those in attendance:

Claude Wakeland, Parma, Id.; W. P. Hayes and family, Urbana, Ill.; E. R. Becker, B. B. Fulton, Ames, Iowa; J. W. McColloch and family, Roger C. Smith, Manhattan, Kans.; R. H. Beamer and wife, Warwick Benedict and wife, Lawrence, Kans.; F. C. Hottes, R. W. Dawson, St. Paul, Minn.; F. T. Cowan, Billings, Mont.; Eugene F. Powell, Otis Wade, Lincoln, Neb.; H. J. Grady, California Chem. Co., N. Y. City; G. A. Bieberdorf, Fred W. Bieberdorf, Stillwater, Okla.; M. D. Farrar and wife, Brookings, S. D.; S. J. Snow, Salt Lake City, Utah; C. L. Corkins and family, E. J. Udine, Laramie, Wyo.; J. M. Osborn, Wheatland, Wyo.; C. P. Gillette and family, C. R. Jones and wife, George M. List and wife, J. L. Hoerner and wife, R. G. Richmond and wife, Miriam A. Palmer, Geo. S. Langford, Sam C. McCampbell, B. O. Longyear and family, L. W. Durrell, C. D. Learn, Leonard Johnson, Fort Collins, Colo.; J. H. Newton and wife, Paonia Colo.; A. C. Maxson, Great Western Sugar Co., Longmont, Colo.; E. G. Grill, Boulder, Colo.; Eva Doonan, Denver, Colo.; Eunice Dalzell, Buffalo, Wyo.

The following are the subjects of the more formal discussions given during the different sessions:

History and Flora of Pingree Park.—B. O. Longyear.

The Place of Insect Control in the Wheat Improvement Campaign in Kansas. —J. W. McColloch.

The Hibernation of Rodents.—Otis Wade.

A New Japanese Beetle in New Jersey and New York.—R. W. Dawson.

The Spinning Habits of *Samia gloveri*.—R. W. Dawson.

The Spray Residue Problem.—Dr. C. P. Gillette.

Recent Work on Insect Carrige of Disease.—E. R. Becker.

A New Cherry Pest.—George M. List.

The Shipping of Bees and Honey.—R. G. Richmond.

Beekeeping Possibilities in South Dakota.—M. D. Farrar.

Apicultural Work in Wyoming.—C. L. Corkins.

Insect Habits and Geography.—B. B. Fulton.

Alfalfa Insects.—Roger C. Smith.

The Alfalfa Weevil.—S. J. Snow.

Alfalfa Weevil Conditions in Colorado.—J. H. Newton.
Alfalfa Weevil in Wyoming.—E. J. Udine.
Volck Oil.—H. J. Grady.
The Snowy Tree Cricket.—Claude Wakeland.
Mechanical Flea Beetle Catchers.—J. L. Hoerner.
Insect Conditions in Oklahoma.—G. A. Bieberdorf.
A Photometric Method for Determining the Amount of Food Consumed and Time of Feeding of Grasshoppers.—G. S. Langford.
The Mormon Cricket in Montana.—F. T. Cowan.

Conditions for collecting were very favorable and many of the workers specializing in different groups were much pleased with the material taken. There was a renewed interest in the possibility of working up the insect fauna of this high altitude region. It is hoped that the efforts of the different workers can be united in a way that an annotated list may be available within the next year or two.

There was a general discussion as to the advisability of forming a permanent organization, but the consensus of opinion was that there was little need for such an organization, and that it might interfere with the informal meetings now being held. It was decided to continue the meetings as they have been in the past, with only a very informal organization, and the gathering to make such rules as they desired at each meeting. The officers elected to plan for next year's meetings were C. P. Gillette, Chairman; W. P. Hayes, Vice Chairman; G. M. List, Secretary; C. R. Jones, Treasurer. The Fifth Conference will be held in the same place and at about the same season of the year in 1927.

A brief summary of the various discussions presented is being mimeographed and will be mailed to a limited number. Copies may be secured by anyone requesting them.

September 28, 1926.

GEORGE M. LIST,
Secretary, Rocky Mountain Conference of Entomologists

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1926

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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The November issue of the American Bee Journal announces that controlled mating of queens has been successfully accomplished for the first time in history. This goal of three generations of beekeepers has been won by Lloyd R. Watson of Alfred, New York, in the face of difficulties which might well daunt a less determined and persistent individual. The apparently impossible has been solved and although there is a great difference between experimental work and practical application, this discovery makes possible the improvement of the honey bee by scientific breeding. It is rightly considered the most important contribution along apicultural lines within the present generation. The discover is entitled to the heartiest congratulations from beekeepers throughout the world and as the details of his methods become known, it is more than probable that they, possibly with some modifications, may have both practical and scientific applications in other fields of biology.

The August, 1926, number of Scientific Agriculture gives an account of the conferring of the C. S. T. A. Fellowship for 1926 by the Canadian Society of Technical Agriculturists upon William Lochhead, Emeritus Professor of Entomology at McGill University. This is said to be the highest honor in the gift of the society. Professor Lochhead was born at Listowel, Ont., on April 3, 1864, received his B. A. degree from McGill University in 1885 and his M. Sc. from Cornell in 1895. Commencing in 1898, Prof. Lochhead was professor of biology for 8 years in the Ontario Agricultural College, and was then appointed to a similar chair at Macdonald College when that institution was opened in 1906, and

remained in charge of the Biology Department until 1920. From 1920 until his recent retirement on account of illness, he filled the position of professor of entomology and zoology. He remains officially identified with Macdonald College as Emeritus Professor of Entomology. A fullpage reproduction is given of a portrait of Professor Lochhead painted by G. Horne Russell, P. R. C. A., which now hangs in the library of Macdonald College. It is said that Prof. and Mrs. Lochhead now reside at Ste. Anne de Bellevue, close to the gates of Macdonald College. His American colleagues extend their congratulations to Professor Lochhead as the recipient of this honor, and wish him a speedy return to health.

Obituary

EDWIN A. HARTLEY

Entomological Science has suffered a severe loss in the death of Professor Edwin A. Hartley of the New York State Forestry School of Syracuse University, who died from an acute attack of appendicitis October 15, at the early age of thirty-three. Professor Hartley was a resident of Oregon and studied at the Oregon Agricultural College, where he received the degree of Bachelor of Science in 1918. During his college career and later, he was engaged in forestry work in Oregon and Washington, part of the time in the United States Forestry service.

In the fall of 1919, he entered Ohio State University for graduate work and as a graduate assistant, holding this position for two years and completing his graduate course for the degree of Master of Science in 1921. Immediately after completing his graduate work he was employed by the Pennsylvania Bureau of Plant Industry as an Entomological inspector but soon after, in 1922, he accepted the position of assistant professor of Entomology in the Syracuse Forestry School. His experience in forestry work and his training in Entomology fitted him particularly well for this position and he was rapidly gaining prominence as a teacher and investigator.

He was a man of winning personality and made hosts of friends everywhere he went. He was the kind of student who was a joy to the teacher, industrious, fertile in ideas, quick of understanding, painstaking and thorough in his work and cheerful in disposition. He was a leader among his fellows, the first President and one of the most active and influential members of the Ohio State University chapter of the Gamma Alpha Graduate Society, and largely responsible for shaping

the policies and ideals of this growing society. He was a very capable investigator and published a number of papers on Entomological subjects, the most important perhaps, being the report upon his studies on the Development of Aphid Parasites, published in the Ohio Journal of Science.

He was a member of the Sigma Xi Society, the Association of Economic Entomologists, Entomological Society of America and other scientific associations.

A host of friends and associates will mourn his loss and share the sorrow that has come to his young wife and near relatives.

HERBERT OSBORN

Reviews

New Observations Upon Bees, by FRANCOIS HUBER, 1814. Translated by C. P. Dadant, 230 pages, 14 plates, American Bee Journal, Hamilton, Illinois, 1926.

The celebrated Swiss naturalist, Francois Huber, first published his observations on the behavior of the honeybee in 1792 and in 1814 he added to the original work and issued his complete work on this subject in two volumes. In 1808 there was published an English translation, obviously drawn only from what later constituted volume one of his complete work. Later English editions appeared in 1821 and 1841 which purported to be translations from the original, but all three of these early translations are identical and all contain the same amusing errors. The present translation by Mr. C. P. Dadant is, therefore, the first complete translation of this noted work into English, and the translator deserves the thanks of every student of bees for making it available to those who read English better than any other language. It would be superfluous to stress the place which the work of Huber has in the development of our knowledge of bees, for his is the first and outstanding investigation in this field, made all the more noteworthy because of the fact that he was blind at the time when all the work was done.

E. F. PHILLIPS

Honey Plants of North America (North of Mexico) by JOHN H. LOVELL, pages iii–408, 129 illustrations, The A. I. Root Company, Medina, Ohio, 1926.

This volume, for which beekeepers have long been looking, has at last appeared. It is divided into four parts which deal respectively with nectar secretion, pollen plants, nectar plants and descriptions of the beekeeping possibilities of the various states of the United States. The descriptions of pollen and nectar plants are accompanied by excellent reproductions of photographs, which add greatly to the value of the book to those who are not botanists. Information regarding the value of the various species from a beekeeping standpoint has been gleaned from personal observations, a study of the beekeeping literature and from letters and reports received from a large number of the better beekeepers in the various states.

Perhaps no one knows better than the author himself that this book is not perfect, for it is quite out of the question for any one to write a pioneer book of this character and present entirely accurate information in so wide a field. This is especially true when a complete presentation of these subjects would require years of travel and personal observation. Perhaps a considerable proportion of the readers of the book will be able to find what they consider to be errors, but as a whole this book is so great an advance over any previous attempt in this field that it is virtually monumental. It is not a book which one would sit down to read through, but it is a book which will serve as an admirable work of reference, and it is safe to predict that it will be used more in years to come than immediately. Beekeepers have not been able heretofore to consult such a work, and it will take time for them fully to appreciate the vast amount of information which the author has here presented. The author and the publishers are sincerely to be congratulated on adding this book to the beekeeping literature of the country. It is also a comfort to have correct scientific names given to the important honey plants, when too frequently in earlier literature such names have been applied incorrectly in many cases.

Those interested in beekeeping can be assured that in getting this book they are making a real addition to their libraries.

E. F. PHILLIPS

Insects of Western North America. A Manual and Textbook for Students in Colleges and Universities and a Handbook for County, State and Federal Entomologists and Agriculturists as well as for Foresters, Farmers, Gardeners, Travelers, and Lovers of Nature, by E. O. ESSIG, Associate Professor of Entomology, University of California. Pp. i–ix, 1–1035. The Macmillan Company. New York. 1926.

The long looked for copy of Essig's "Insects of Western North America" came in this afternoon, and I have spent three most interesting hours looking through it, reading sketches here and there. I have known Professor Essig and his work for a long while, and of course was expecting a thorough and masterly piece of work in this book. I have not been disappointed. Indeed, I am amazed at the wealth of material and information that he has crowded between the covers of this book.

It is the first book that we have had dealing especially with Western insects, and the ground is covered so thoroughly that another book of this nature will not be called for for a long while. This book is indispensable for anyone interested in Entomology in Western North America, and is quite as important for the Eastern worker who wishes to know anything about Western insects. The book deals with the insects found in all of the states West of the Rocky Mountains.

Coming as it does from the pen of the working economic entomologist we expected to find, and do find, particular emphasis placed on the species of economic importance. This is as it should be, for after all the chief interest of most working entomologists and certainly the chief interest of the public in general is in the insects that affect our plants, our food materials, our comfort and our health.

However, the systematic side of the subject has not been in any way neglected. Professor Essig has followed Comstock in recognizing twenty-five orders of insects.

The sequence in which these orders are discussed is, however, not the same. The key to the orders is simple and apparently very usable. This is true also of the tables for the groups and families in the different orders.

While it would of course be impossible to give even a list of all the species of different orders in a work of this kind, the author seems to have selected the most common or most important or most interesting kinds in each group, and his descriptions and comments are always enlightening. The notes on distribution and the bibliographical references are very helpful.

As would be expected, the control measures he suggests are the ones most approved, and we know that the author is personally acquainted with the efficacy of most of these. The illustrations (many of which are from the author's photographs) are, as a rule, very good—many of them excellent—and they well illustrate the insects or the insects' habits. There are a few unfortunate exceptions to this rule.

I have not looked through the book for typographical or other errors, but the book seems to be well up to the usual high Macmillan standard. The small type that is used in describing many of the species of lesser importance has enabled the author to discuss a great many forms that would otherwise have had to be omitted or the book would necessarily have been much larger.

It seems to me very unfortunate that Professor Essig did not follow more closely the list of common and scientific names approved by the American Association of Economic Entomologists. Some of us may prefer the names he has used, but if either the common or scientific names are ever to mean anything to us we must agree upon a certain set of names and use them until some good reason is given for a change. While we may not all approve of all of the names given out by our Committee on Nomenclature, I believe that the publication of the list they have given us is the most important thing that has been done toward the stabilizing of our nomenclature, and all economic entomologists should use it as it is and only make changes when they are approved by the Committee. The Committee will always be ready to make changes when it can be shown that it is to the best interest of the science to do so. Of course much of the work on this book was completed before this list of common and scientific names was published. When the insect under discussion was well known under some other generic or specific name than that now used by the author, the older name has been given in parenthesis. This is very helpful, and it will greatly aid one in finding some of his old acquaintances that are masquerading under new or little known names. These names are given in the index and this, too, will help one to locate them. The index of host plants adds much to the usableness of the book.

R. W. DOANE

Current Notes

Mr. D. M. Daniel of the Geneva (N. Y.) Agricultural Experiment Station, visited the Vineland, Ont. laboratory September 14.

Dr. V. E. Shelford, of the University of Illinois, visited the laboratory at Saskatoon, Sask., on September 4.

The Entomological Society of Ontario held its annual meeting at the Ontario Agricultural College, Guelph, Ont., in mid-November.

Mr. W. W. Frye, a graduate of Iowa Wesleyan University, is taking graduate work in Zoology and Entomology at Iowa State College.

Dr. L. O. Howard visited the Gipsy Moth Parasite Laboratory at Melrose Highlands, and the Corn Borer Laboratory at Arlington, Mass., on September 1.

Professor George A. Dean, W. P. Flint, L. H. Worthley and D. J. Caffrey, made an inspection of the corn borer conditions in Michigan, Ohio, and Ontario, August 23–26.

A thorough scouting of the Niagara peninsula, Ont., for the Oriental peach moth, has resulted in light infestations being discovered in a number of localities.

Mr. W. W. Newby, a graduate of the University of Kansas, has accepted a graduate assistantship in Zoology and Entomology at Iowa State College, Ames, Iowa.

Mr. H. K. Riley, a graduate of Louisiana State University, has accepted an assistantship in the Entomology Section of the Agricultural Experiment Station at Ames, Iowa.

Dr. C. Mickel, Professor of Systematic Entomology at the Minnesota University College of Agriculture, was a visitor at Ottawa on September 15, examining types of Mutillidae in the National Collection.

Mr. George M. Stirrett has been appointed to the position of entomologist in charge of European corn borer investigations. Mr. Stirrett reported for duty at Chatham, Ont., on September 15.

Mr. W. B. Cartwright has taken charge of the Sacramento, Calif., field laboratory of the Bureau of Entomology, to fill the vacancy caused by C. M. Packard's transfer to West Lafayette, Ind.

Mr. E. W. Davis, of the United States Bureau of Entomology, who is engaged upon beet leaf-hopper investigations at Toppenish, Wash., was a visitor at the Victoria, B. C. laboratory on September 3.

Recent visitors at the Japanese Beetle Laboratory include Alma Keeler, Columbus, Ohio; Edgar A. Miller, Longwood, Fla.; J. van Houts, Medan, Sumatra, and Dr. J. Borcea, Professor at the University of Jassy, Jassy, Roumania.

Professor W. C. O'Kane and W. A. Osgood, of the New Hampshire Agricultural Experiment Station, and H. N. Worthley, Extension Entomologist of Pennsylvania, were recent visitors at the Arlington, Mass. laboratory of the Bureau of Entomology.

Mr. Ralph Hopping reports that the spruce budworm outbreak in the Barkerville district, B. C., extends over an area of 1000 square miles. Outbreaks of this insect have also developed in other sections of British Columbia.

Mr. H. G. Crawford, Chief of the Division of Field Crop and Garden Insects, Entomological Branch, was married to Miss Edith Woodman of Grand Pre, N. S., on September 1, the ceremony taking place at the home of the bride.

Professor H. M. Wight, Associate Professor of Zoology, Oregon Agricultural College, Corvallis, Oregon, has secured a leave of absence for a year in order to take graduate work in the Department of Zoology and Entomology, Iowa State College, Ames, Iowa.

Mr. M. McPhail, a graduate of Clemson College who has been taking graduate work in entomology at Iowa State College, has accepted a position as entomologist in the lower valley substation, Mercedes, Texas. Mr. McPhail reported at Mercedes on November 1.

Mr. David Dunavan has accepted an assistant professorship in Zoology and Entomology at the South Carolina Agricultural College, Clemson, South Carolina. Mr. Dunavan has been taking graduate work in Entomology at Iowa State College, Ames, Iowa, during the past year.

Resignations in the Bureau of Entomology have recently been announced as follows: T. F. Gatchings, A. C. Davis, C. E. Burnside, H. M. Tietz. The following temporary appointments have terminated: H. L. Weatherly, H. Beerman, W. J. Douglass, D. M. DeLong, S. F. Grubbs, S. C. Lyon, and K. E. Gibson.

Mr. R. F. Sazama, who has been associated with Dr. B. A. Porter at Vincennes, Ind., in connection with apple insect investigations of the Bureau of Entomology, has been given a furlough for one year, to undertake graduate studies at the Massachusetts Agricultural College.

Dr. Chester I. Bliss, who has been engaged on several occasions in Deciduous Fruit-Insect Investigations of the Bureau of Entomology, has been appointed Associate Entomologist and assigned to duty at New Orleans, La., in connection with work on the camphor scale.

A very complete survey for the apple maggot has been made in the orchards of the Annapolis valley under the direction of Mr. Arthur Kelsall. Owners whose orchards were found infested were given advice as to the best means of combating this pest.

Messrs. J. N. Tenhet and K. B. McKinney, connected with the tobacco insect laboratory of the Bureau of Entomology at Clarksville, Tenn., have been temporarily transferred to the Federal Horticultural Board, effective October 1, and will report to F. S. Puckett, Houston, Texas, for duty in connection with the pink bollworm service.

Prof. R. H. Pettit and Mr. Marston of the Michigan Agricultural College, Dr. Luginbill, in charge of the Federal corn borer laboratory at Monroe, Mich., and Mr. C. O. Larraby, in charge of the Federal corn borer scouting and quarantine work in Michigan, were recent visitors at the Chatham, Ont., laboratory.

Mr. C. M. Packard has accepted a transfer to the West Lafayette, Ind. field laboratory, where, besides his regular duties as in charge of that station, he will be responsible for the general coordination of all the Hessian fly investigations of the Division of Cereal and Forage Insect Investigations of the Bureau of Entomology.

Mr. E. W. Laake of the United States Bureau of Entomology, visited the Kansas State Agricultural College, November 1 to 4, while conducting a demonstration of ox-warble eradication on the Casement Ranch. He addressed the Entomology and Zoology Seminar on the projects of the division, with especial reference to the ox-warble.

Mr. E. Graywood Smyth, formerly of the Bureau of Entomology, who has been executive assistant of the Philadelphia Real Estate Directory for the past two years, has recently returned from a three months' vacation in northern Italy where he collected a large number of Coleoptera. He reports that the common cockchafer, *Melolontha vulgaris* Fabr., is so extremely abundant in some districts about Milan as to completely defoliate young oak trees in what little forest remains. Its local name, "il maggiolino," is a household word among Italians. No apparent measures were taken to suppress it.

The following resignations from the Entomological Branch, Canadian Department of Agriculture, are announced: George Ficht, Chatham, Ont.; F. Jeffrey, J. R. B. Coleman, Fredericton; T. B. Mathieson, Victoria, B. C.; E. R. Tinkham, Lethbridge, Alta; J. G. McPharlin, Toronto; J. Stanley and H. H. Ross, Agassiz, B. C.; all to resume their studies; N. A. and D. F. Paterson, Annapolis Royal, N. S. The temporary appointments of A. H. MacAndrews, N. L. Cutler, and A. R. Graham have terminated.

Professor J. A. Manter, of the Connecticut Agricultural College, recently spent several days at the Japanese Beetle Laboratory inspecting the different phases of the work in progress. Professor Manter has been visiting several of the large stations in the East and was specially interested in the parasite work of the Bureau, as he will conduct a course in insect parasitology at the Connecticut Agricultural College during the coming scholastic year.

Mr. G. A. Ficht of the Canadian Department of Agriculture has secured a leave of absence in order to take graduate work in Entomology at Iowa State College, Ames, Iowa. Mr. Ficht is a graduate of Ontario Agricultural College, and has a master's degree from the University of Western Ontario. During the past three years he has been working with Mr. H. G. Crawford at the European Corn Borer Laboratory, Chatham, Ontario.

Mr. C. F. Henderson has been appointed agent of the Bureau of Entomology, effective September 15, and will sail from San Francisco on or about October 9 for South America to make studies of the sugar-beet leafhopper and its natural enemies. This work has been undertaken in cooperation with the University of California. He will probably first visit Tucuman, Argentina, where he will confer with Dr. G. L. Fawcett, Pathologist of the Tucuman Agricultural Experiment Station.

Early in September, Mr. A. F. Burgess, in company with Messrs. Arthur Gibson, L. S. McLaine and S. H. Short, of the Dominion Department of Agriculture, made an inspection trip along the international line between Quebec and Vermont, where scouting work is being done by the Canadian Government and the Bureau of Entomology. On September 8, at Rutland, Vt., Mr. Burgess conferred with Vermont State officials concerning gipsy moth work; and on September 9 he attended the state gipsy moth quarantine hearing at Hartford, Conn.

From July 27 to July 30, Dr. L. O. Howard, accompanied by W. R. Walton and D. J. Caffrey, inspected the corn borer field and laboratory work in Michigan, Ohio, and Ontario. Consultations were held at the Bureau laboratories at Sandusky, Ohio, and Monroe, Mich., and at the laboratory of the Dominion Entomological Branch at Chatham, Ontario. At Chatham the party was joined by L. S. McLaine, A. B. Baird, and C. W. Smith, of the Dominion Entomological Branch. Messrs. McLaine and Baird accompanied Dr. Howard to St. Thomas, Ontario.

Mr. Arthur Gibson, Dominion Entomologist, visited the Montreal inspection office on September 1, in company of Mr. L. S. McLaine. They later proceeded to Rouse's Point, Quebec, where they were joined by Mr. A. F. Burgess of the Melrose Highlands laboratory, Mass., who accompanied them on a motor trip through the gypsy moth quarantined area in Quebec as far as Coaticooke. Mr. Gibson then visited Sherbrooke and Quebec to discuss the displaying of Branch entomological exhibits at exhibitions held in these localities. In mid-September Mr. Gibson visited Toronto, Vineland, and Niagara Falls, Ont., in connection with Branch extension, research, and inspection work.

The U. S. National Museum has recently received as donations two important collections of insects. One of these is from John D. Sherman, Jr., of Mount Vernon, New York, comprising about 20,000 specimens of water beetles of the families Dytiscidae and Haliplidae, and representing about forty years of entomological activity on the part of the donor. This Mr. Sherman gives "in loving appreciation and honor of Dr. E. A. Schwarz." The second donation is from Dr. E. A. Chapin, formerly of the Bureau of Animal Industry, but recently appointed to the staff of the Bureau of Entomology as a specialist in beetles. This collection comprises fleas, lice, and other ectoparasites, and is the largest addition in this group ever received by the Museum.

Dr. Alfred E. Emerson, Professor of Ecology at the University of Pittsburgh, has been granted a Guggenheim fellowship for a year's study in Europe, to work on the phylogeny of termite castes. Dr. Emerson will visit termite specialists and museums in Italy, Sweden, and Denmark, and will also study in the field the primitive Hodotermes in Tunis. Dr. Snyder has prepared about 120 species of identified termites from the U. S. National Museum collection for comparative study and exchange with European museums by Dr. Emerson. Dr. Emerson visited the U. S. National Museum from September 20 to 23, and sailed for Europe on September 29. He was given a dinner at the Cosmos Club on September 22 by entomologists and specialists of the Bureau of Entomology and the National Museum.

Dr. J. M. Swaine visited the Maritime Provinces during August and early September to review the progress of research work on forest insect problems. From August 5 to 12 he visited the laboratories at Fredericton, N. B., Annapolis Royal and Kentville, N. S., conferring with Messrs. L. J. Simpson, Arthur Kelsall and A. H. Graham. Dr. Swaine later proceeded to Halifax, N. S., where he was joined by Dr. F. C. Craighead, of the United States Bureau of Entomology and Mr. Alden of the Oxford Paper Company. Accompanied by Mr. O. Shierbeck, Chief Forester for Nova Scotia, and A. H. MacAndrews, they spent several days in reviewing the spruce budworm situation in Cape Breton. After returning to New Brunswick and

making a survey of forest insect conditions there, Dr. Swaine proceeded to Ottawa, arriving at headquarters on September 13.

On August 25, Dr. E. A. Schwarz was retired at his own request. This is an event of historic interest because of his long and valuable services, and a deep personal interest to members of the Bureau on account of the affectionate respect in which he is held by every one. Dr. Schwarz may truly be called a great entomologist, and his wonderful knowledge, his thorough scientific spirit, and his helpful attitude towards the younger workers have made his career in the entomological service of the Government stand out above all others. It would be almost impossible to exaggerate the value of his services. Coming to Washington in 1878, Dr. Schwarz has remained constantly in the Department of Agriculture except for the two years 1879–81, when Professor Comstock was Chief Entomologist and Dr. Schwarz assisted Riley in the work of the Entomological Commission. He has been connected with many important investigations and has done remarkable work. His influence on his associates has always been inspiring and has helped greatly to strengthen all of us in our search for scientific truth. Fortunately, Dr. Schwarz will retain his title of Honorary Custodian of the Coleoptera in the National Museum, and will be found at his post as long as his physical condition will permit. So it is not a parting from our dear friend, after all.—L. O. H.

A recent addition to the staff of the Japanese Beetle Laboratory, Riverton, N. J., is Dr. H. W. Allen, who has been assigned to the parasite work of the Division. Dr. Allen is a native of Massachusetts and received the degree of Bachelor of Science from Massachusetts Agricultural College in 1913. For the following five years he was connected with the Gipsy Moth Laboratory at Melrose Highlands, Mass., as scientific assistant. Following this, nearly a year and a half was spent in the army, in pathological laboratory work and as a student in army medical schools. During 1919 he was connected with the U. S. Public Health Service, acting in charge of the Pathological laboratory at Hospital No. 2, Chicago, Ill. During 1920 he was again connected with the Bureau of Entomology as scientific assistant, being stationed at the European Corn Borer Laboratory, Arlington, Mass. In 1921 and 1922 he was at the Mississippi Agricultural and Mechanical College as instructor, assistant professor, and associate professor, in the Department of Zoology and Entomology; and in 1923 with the Mississippi Agricultural Experiment Station as associate entomologist. In 1923 he received the degree of Master of Science from Mississippi Agricultural and Mechanical College. During the year 1925–26, Dr. Allen held a fellowship at Ohio State University, where he was awarded the degree of Doctor of Philosophy at this year's Commencement.

The third annual conference of entomologists working in Connecticut was held at the Connecticut Agricultural College, Storrs, on October 29. Between fifty and sixty entomological workers were present, and Dr. W. E. Britton was elected chairman of the meeting. The following program was fully carried out except that Mr. L. B. Smith could not be present and his subject was covered very acceptably by Mr. E. A. Richmond. Greetings, C. L. Beach, Pres. Conn. Agricultural College, Storrs; The Training of Entomological Investigators, Prof. G. H. Lamson, Jr., Conn. Agricultural College, Storrs; Summary of Six Years' Experiments in Orchard Dusting

and Spraying, M. P. Zappe, Conn. Agricultural Experiment Station, New Haven; Some Insect Pests Which Have Recently Appeared in Connecticut, W. E. Britton, State Entomologist, New Haven; The Occurrence of *Autoserica japonica* in the United States, E. P. Felt, State Entomologist, Albany, N. Y.; Present Status of the European Corn Borer in the United States, L. H. Worthley, In Charge of Federal Control Work, Arlington, Mass.; Recent Developments in the Control of the Japanese Beetle, Loren B. Smith, In Charge of Federal Work, Riverton, N. J.; Present Status of the Gipsy Moth, Brown-tail Moth, and Satin Moth, A. F. Burgess, In Charge of Federal Moth Work, Melrose Highlands, Mass.; Recent Observations on the Codling Moth in Massachusetts, A. I. Bourne, Agricultural Experiment Station, Amherst, Mass.; Habits and Life History of the Asiatic Beetle, *Anomala orientalis*, R. B. Friend, Agricultural Experiment Station, New Haven; Work of the Season with the Oriental Peach Moth, Philip Garman, Agricultural Experiment Station, New Haven; Recent Studies on the Bean Weevil, J. A. Manter, Agricultural College, Storrs.

Horticultural Inspection Notes

Mr. Nile M. Border, an inspector of the Federal Horticultural Board, was recently transferred from New York to Philadelphia.

Mr. W. F. Freeman, in charge of the inspection work of the Federal Horticultural Board in New York, was in Washington, D. C. recently for a conference with members of the Board.

Messrs. George Becker of the Federal Horticultural Board, B. R. Coad of the Bureau of Entomology, and R. E. McDonald, State Entomologist of Texas, were in Washington recently for a conference relative to the Thurberia weevil.

A summary of the road inspection work carried on in Arizona, as reported by Dr. Oscar C. Bartlett, State Entomologist of Arizona, in the Arizona News Letter of August 31, shows the following figures: Number of cars inspected, 13,486; number of cars carrying contraband articles, 1,922.

Because of the more or less general infestation of European chestnuts with the European Codling Moth and other injurious insects which do not occur in the United States, the Secretary of Agriculture has issued an order, effective October 1, 1926, prohibiting entry from European countries of all kinds of chestnuts, walnuts, filberts, cobnuts and acorns, except under permit and under certain safeguards.

Many states do not require the inspection and certification of herbaceous plants and those grown in greenhouses, while others require that all plants be inspected before movement within the state. Mr. W. C. Jacobsen, Chief of the Bureau of Plant Quarantine and Pest Control of the State of California, calls attention in a recent number of the State Department of Agriculture News to the fact that all shipments of plants and seeds entering the state or moving between counties within the state must be inspected by a county horticultural commissioner or one of his assistants when it arrives at destination.

The area under quarantine on account of the satin moth, an insect injurious to poplars and willows, has been enlarged to include for the first time territory in Connecticut as well as additional territory in Rhode Island, Massachusetts, New Hampshire, and Maine. No additions to the area already under quarantine in the State of Washington were deemed necessary. The revised quarantine approved by the Secretary of Agriculture October 30, 1926, becomes effective November 15, 1926. The territory added by this revision consists of approximately 88 square miles in Connecticut, 631 in Rhode Island, 755 in Massachusetts, 837 in New Hampshire, and 802 in Maine.

Japanese Beetle Quarantine No. 48 has been revised to apply to the additional states of New York and Connecticut. It formerly included the states of New Jersey, Pennsylvania, and Delaware. Under the provision therefore in the quarantine, it is expected that the restrictions will be limited to the areas in the quarantined states designated by the Secretary of Agriculture as infested by the Japanese beetle, or immediately threatened with such infestation. The only amendment to the regulations in connection with the revision of the quarantine is the enlargement of Regulation 2 to include the new territory represented by the spread of the beetle in the states of New Jersey, Pennsylvania, and Delaware, and the territory covered by such spread into New York and Connecticut. The amendment to Regulation 4, promulgated July 3, 1926, and relating to the movement of hay or straw when used as packing for materials or articles other than fruits or vegetables, has been incorporated in this revision. The description in the Appendix of the different classes of nurseries with respect to control measures has been slightly revised and a proviso has been added to the paragraph under "Supplemental Instructions," page 11 of the previous edition—effective May 15, 1926—relating to shipments of nursery stock with soil from nurseries of the second class, modifying the conditions of certification and shipment as to certain classes of plants.

A conference of much significance to the agricultural interests of Mexico and the United States took place at Guadalajara, Jalisco, Mexico and Mexico City in September between officials of the Mexican Department of Agriculture and Development, plant quarantine officials from the United States, representatives of the Southern Pacific Railroad of Mexico and the Camara Agricola Nacional del Noroeste de Mexico (Mexican Northwest Agricultural Chamber). The conference, which was informal and not an official international affair, was arranged by the Camara Agricola on the invitation of the Mexican Department of Agriculture and Development. Those who participated were Sr. Juan A. Gonzalez, Sr. Manuel Alcazar, Sr. Rafael Batiz Paredes, of the Secretariat of Agriculture and Development, Sr. F. J. B. Gonzalez, Secretary of the Camara Agricola, Mr. E. A. H. Tays, Director of the Camara Agricola, Dr. A. W. Morrill, Consulting Entomologist of the Camara Agricola, Mr. P. L. Bell, Industrial and Colonization Agent of the Southern Pacific Railroad of Mexico, Dr. G. P. Clements, Manager of Agricultural Department, Los Angeles Chamber of Commerce, Dr. O. C. Bartlett, Arizona State Entomologist, and Mr. W. C. Jacobsen, Chief of Division of Plant Quarantine and Pest Control, California Department of Agriculture. Further information in regard to the above mentioned conference is contained in the following statement issued by representatives of the Camara Agricola at Nogales after their return from Mexico City: "The Camara

Agricola Nacional del Noroeste de Mexico was organized several months ago at Nogales, Sonora, for the purpose of representing the agricultural interests of the Mexican West Coast states of Sonora, Sinaloa and Nayarit, and more especially the interests of the growers of vegetables, bananas and other agricultural products which are exported through the port of Nogales. One of the principal problems in this connection is that of international quarantines. The Mexican Department of Agriculture and Development and the above mentioned Camara believe that a better understanding of the international plant quarantine problems will do much toward facilitating legitimate interchange of agricultural products with protection to the agricultural interests of both Mexico and the United States. "At this time the chief plant quarantine interest centers in the establishment of an effective quarantine station and fumigation plant in the state of Jalisco at some point east of the deep barranca which serves as a barrier between the West Coast and the interior of the Republic. California and Arizona are recognized as among the foremost states in the United States in the development of plant quarantines for the protection of their areas against pests from other states and from foreign countries. The states of California and Arizona and the West Coast states of Mexico have many plant quarantine problems in common and it was therefore especially desired by West Coast agricultural interests and the Federal Department of Agriculture and Development that the men in charge of plant quarantine activities in these states visit the territory between Tepic, Nayarit and Guadalajara, Jalisco, and personally observe the excellent opportunity afforded by the barranca and adjoining territory for protecting the West Coast against the fruit fly of oranges, mangoes and certain other fruits, the avacado weevil, the potato weevil, the pink boll worm of cotton, and other pests from which the West Coast states are now free. It was also desired that advantage might be taken of the experience of the American officials in the consideration of the best location of a fumigation and inspection station. These matters were discussed at conferences on September 14 with Sr. Ignacio L. Figueroa, Director General of Agriculture and Livestock, and later with Sr. Luis Leon, Secretary of Agriculture and Development. The various agricultural experts, after careful consideration of all the factors involved, were agreed on the most practical plans for the protective work." It is reported that the Mexican Government is planning to establish an extensive fumigation plant at Guadalajara, state of Jalisco, with headquarters for the plant inspection service for the protection of the West Coast at La Quemada, also in the state of Jalisco.

Apicultural Notes

The 37th annual convention of the California State Beekeepers' Association is scheduled to be held at Los Angeles, on December 9 to 11.

A new state beekeepers' organization is reported from Idaho with Mr. R. D. Bradshaw, of Wendel, as president; and Mr. C.H. Stinson, of Twin Falls, as secretary.

Recent visitors at the Bee Culture Laboratory of the Bureau of Entomology included Dr. Stepan Soudek of Czechoslovakia, and Dr. E. F. Phillips of Cornell University.

Mr. James I. Hambleton, Mr. E. L. Sechrist, and Mr. J. E. Eckert, of the Bee Culture Laboratory of the Bureau of Entomology, attended the Root-Langstroth Memorial Meeting at Medina, Ohio, on September 21, 22 and 23.

Mr. Thomas William Cowan, formerly editor of the British Bee Journal and president of the British Beekeepers' Association, died last May. He was the author of two books on beekeeping.

The sixth annual meeting of the Wyoming Beekeepers' Association will be held at Thermopolis, Wyoming, November 30 to December 3. The program is featured by educational, marketing, and legislative topics.

Dr. Ralph L. Parker, who went to Kansas State Agricultural College in the fall of 1925, has been promoted to the position of Assistant Professor, in charge of the work in apiculture.

Mr. Edwin J. Anderson, who took his master's degree in Apiculture at Cornell University in 1925, and who taught at Clemson College, S. C., last year, has been appointed as extension specialist at Pennsylvania State College.

The following men are taking graduate work in Apiculture at Cornell University this year: Everett Oertel of Wisconsin, Virgil Argo of Washington, Paul Needham of New York, A. C. Gould of West Virginia, and E. J. Hambleton of Ohio.

Morton H. Cassidy, Assistant Professor of Beekeeping at the Massachusetts Agricultural College, resigned his position to take effect September 1, and has gone to Hawaii for his health, where he has received an appointment in the Science Department of the Konawaena School, Kealakekua.

George H. Rea, recently extension specialist at Pennsylvania State College but formerly in the same work at Cornell University, has been reappointed to the work in New York State, as Assistant Professor of Apiculture, vice R. B. Willson, resigned. Mr. Rea took up his new duties October 1.

Mr. Philip J. Baldensperger, who visited the United States and Canada in the fall of 1924, having come to the International Apicultural Congress at Quebec as the representative of the French societies of beekeepers, was elected president of the International Apis Club at the Annual General Conference in London in July.

Mr. Fr. Leuenberger, President of the Schweizerische Verein Bienenfreunde, editor of the Schweizerische Bienenzeitung and in charge of apiary inspection in German Switzerland, was recently granted the honorary degree of Doctor of Veterinary Medicine by the University of Zurich, in recognition of his work in the control of bee diseases.

A new book on the subject of beekeeping has recently been published by Mrs. Mary G. Phillips, the wife of Dr. E. F. Phillips, entitled "Honey Bees and Fairy Dust." This book is intended primarily for children. The delightful manner in which the subject is presented makes the book one of the noteworthy offerings of the year.

Mr. Clayton L. Farrar, a graduate of Kansas State Agricultural College, has been appointed to the position formerly occupied by Professor Cassidy at the Massachusetts Agricultural College. This position has been changed to that of Instructor in Entomology and Beekeeping. Mr. Farrar has had an extended experience in beekeeping. He assumed his duties at the College September 15.

Professor and Mrs. E. F. Phillips returned to Ithaca, N. Y. on September 7, after a summer trip through Switzerland, France, England and Scotland. In all these countries they were entertained by numerous associations of beekeepers and visited most of the important places where investigations pertaining to beekeeping are being conducted. While on this trip, Professor Phillips was presented with three medals by different societies which were visited. He also presided at the Annual General Conference of the International Apis Club in London, July 29 to 31.

A beekeeping exhibit has recently been established in the Old National Museum of the Smithsonian Institute at Washington, D. C. The first section of the exhibit consists of a two-story glass observation hive which has a twelve-foot glass tunnel leading to the outside entrance. This exhibit was made possible through the generosity of the A. I. Root Company, Medina, Ohio, and Dadant and Sons, of Hamilton, Illinois, manufacturers of beekeeping supplies. The colony of bees was furnished and installed by the Bee Culture Laboratory. This exhibit has received rather unusual attention and publicity.

The manuscript journal of the Rev. L. L. Langstroth which he kept for forty-five years and in which he recorded his observations on bee behavior and his experiments which led to the making of the modern bee-hive was discovered last spring in an attic in Dayton, Ohio. At the recent meeting held by the Ohio Beekeepers' Association at Medina, Ohio, in memory of Mr. Langstroth this journal was exhibited and was then presented by Mr. A. H. Cowan, grandson of Mr. Langstroth, to the Beekeeping Library at Cornell University.

On September 21 to 23, the Ohio Beekeepers' Association held meetings at Medina, Ohio, the home of the A. I. Root Company. On the afternoon of the first day a service in memory of Mr. A. I. Root was held. On the second afternoon a similar service was held in memory of Rev. L. L. Langstroth. The registration showed that persons were present from sixteen states and several foreign countries. It was announced at this meeting that Miss Florence Naile, Secretary of the Ohio Association, is preparing a Life of Langstroth, which will probably be published within a short time.

Since February, 1925 the Cornell University Beekeeping Library has received gifts of books, volumes of bee-journals and pamphlets numbering 3057. These gifts have come from 223 persons in 29 states of the United States, three provinces of the Dominion of Canada and in 26 other countries. During the summer several societies of beekeepers in France presented money to the library as a memorial to Rev. L. L. Langstroth, and with the money thus obtained the complete library of Professor Robert Hommell was purchased for the Library. In addition to gifts of books and journals, gifts to the endowment fund now amount to $800, with pledges which will considerably increase this amount.

Dr. A. P. Sturtevant, of the Bee Culture Laboratory of the Bureau of Entomology, has assumed charge of the Bureau's new Intermountain Bee Culture Field Station at Laramie, Wyoming. The primary purpose of this station is to work out problems peculiar to beekeeping practice in the intermountain region. The importance of this region is shown by the fact that the State of Wyoming alone has more carload lot producers of honey than any other state in the Union with the possible exception of California. Doctor Sturtevant will be assisted in this work by Mr. J. E. Eckert, who has also been connected with the Bee Culture Laboratory at Somerset, Md. Dr. Sturtevant spoke before the September meeting of the North Carolina Beekeeper's Association.

The following beekeepers' meetings have been scheduled: Western New York Honey Producers' Association, Buffalo, Dec. 1–2; Wisconsin State Beekeepers' Association, Madison, Dec. 2–3; Illinois State Beekeepers' Association, Springfield, first week in December; Montana Beekeepers' Association, Billings, Dec. 6–7; Michigan State Beekeepers' Association, East Lansing, Dec. 9–10; Washington State Beekeepers' Association, Spokane, Dec. 9–11; Idaho State Beekeepers' Association, Boise, Dec. 13; Utah State Beekeepers' Association, Salt Lake City, Dec. 14–15; Empire State Federation of Beekeepers', Syracuse, Dec. 14–16; Colorado, two meetings, one at Grand Junction Dec. 17–18; and the other at Fort Collins, Dec. 20–21; Pennsylvania State Beekeeper s Association, Harrisburg, Jan. 17–21; Cornell Beekeepers' Short Course, Ithaca, N. Y., week of January 24th, and the American Honey Producers' League, New Orleans, La., Jan. 25–27.

Notes on Medical Entomology

In August, F. C. Bishopp, of the Bureau of Entomology, gave talks on the control of poultry parasites at a series of district meetings held at Sweetwater and Stephenville, Texas, under the auspices of the Texas Farm Bureau. He also discussed the work of the Bureau on insects affecting livestock at the "round up" held at the Texas Experiment Substation No. 14, located in the heart of the ranch country near Sonora. On this trip he also visited the Bureau substations at Sonora and Uvalde, as well as the extensive project on the control of the screw worm which is being carried out by ranchmen in Menard County, under the direction of County Agent R. W. Nisbet. The plan followed is that recommended by the Bureau, and the test is being closely watched.

ERRATA

Page 412, line 26 for *Alabama argillacea* Hübn., read *Heliothis obsoleta* Fabr.

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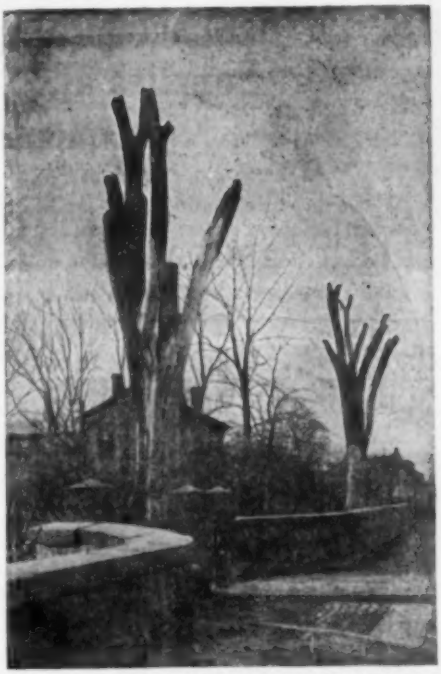

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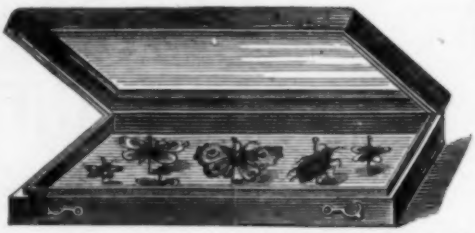

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of the

American Association of Economic Entomologists,

Philadelphia, Pa.

December 28, 1926, to January 1, 1927

Thirty-ninth Annual Meeting of the American Association of Economic Entomologists, Philadelphia, Pa.

Dec. 28, 1926 to Jan. 1, 1927

The 39th annual meeting of the American Association of Economic Entomologists will be held at Philadelphia, Pa., on the above-named dates. The meeting of the Section of Plant Quarantine and Inspection will be held Tuesday, December 28, 1926. The opening business session of the general Association will be held Wednesday morning, December 29, at which time the address of the President will be delivered. The Section of Apiculture will hold its meeting in the afternoon and evening of Wednesday, December 29. Meetings of the general Association will continue Thursday, Friday and Saturday, closing with a final business session. This Association will meet in Room 117, Logan Hall, University of Pennsylvania, 36th Street and Woodland Avenue.

Sectional Meetings

The meeting of the Section of Plant Quarantine and Inspection will be held at 9:30 a. m., Tuesday, and will continue through the day. The Section of Apiculture will meet at 1:30 p. m., Wendesday, with an evening session at 8 o'clock.

Other Meetings

The annual meeting of the American Association for the Advancement of Science, its sections and affiliated societies will be held December 27, 1926 to January 1, 1927.

The Entomological Society of America will open its meeting on Tuesday morning, December 28, and will continue through Wednesday, December 29. The annual public address before that society will be delivered by Professor George H. F. Nuttall of England, on Tuesday evening, December 28, at 8 o'clock. Title: "Insect Parasites of Man."

The annual public address will be followed by a smoker to which all visiting entomologists are invited. The local entomologists will act as hosts.

The extension entomologists and Insect Pest Survey will hold a meeting on Friday, December 31, at 8 p. m. Details of this meeting will be announced at the day session. The Crop Protection Institute will hold its annual dinner and business meeting on Tuesday evening, December 28, at 6 o'clock. The Committee on Policy will hold a meeting at Hotel Normandie on Tuesday morning at 8 o'clock.

Hotel Headquarters

Headquarters for this Association and the Entomological Society of America will be at Hotel Normandie, 36th and Chestnut Streets. Rates as follows:

Single room, without bath	$2.00 and $2.50
Double room, without bath	$4.00
Single room, with bath	$3.00 and $3.50
Double room, with bath	$5.00 and $6.00
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Railroad Rates

Practically all railroads offer reduced fares to the meeting of the A. A. A. S. Members should secure a certificate when purchasing tickets, stating that they are attending the meeting of the American Association for the Advancement of Science; leave the certificate at the registration room for endorsement and validation, and present the certificate when purchasing return ticket to secure one-half regular fare for the return trip.

Dinner

The entomologists' dinner will be held on Thursday evening, December 30, 1926, at 7 o'clock. Announcement of place will be made at the meeting.

Membership

Applications for membership can be secured from the Secretary or from the Committee on Membership. These should be filled out, properly endorsed, and filed with the Secretary or the Membership Committee on or before December 30. Each application must be accompanied with fee of $4.00 to cover dues and subscription to the JOURNAL for the year following election.

Exhibits

Members are requested to make exhibits of appliances, apparatus, photographs, maps or models demonstrating life history or control methods in preventing insect damage. Such exhibits will be displayed near the meeting room. Those wishing to send exhibits should do so in advance and should direct them to L. B. Smith, Japanese Beetle Laboratory, Riverton, N. J., charges prepaid. Mr. Smith will care for them and see to their being transferred to the exhibition room at the opening of the meeting.

Program

SECTION OF PLANT QUARANTINE AND INSPECTION

L. A. STRONG, *Chairman* W. B. WOOD, *Secretary*

Tuesday Morning Session, December 28, 9:30

Address by the Chairman—The National Plant Board—Purposes and Probable Accomplishments. L. A. Strong, Sacramento, Calif.

READING OF PAPERS AND DISCUSSIONS

1. The Effect of the Supreme Court Decision of March 1, 1926, in the Case of the Oregon-Washington Railroad and Navigation Company *vs* the State of Washington on the Basic Quarantine Laws of the Various States. C. L. Marlatt, Washington, D. C.

(The above subject is to be opened by Dr. Marlatt, and will be continued as a "round table" discussion to bring out the views of various quarantine officials.)

2. The Plant Inspection Service of Canada. L. S. McLaine, Ottawa, Canada.

3. The Advantages and Disadvantages of Printed Certificate Tags. S. B. Fracker, Madison, Wis.

The Inspection of Vehicular Traffic in the Enforcement of Plant Quarantines:

4. As Practiced in the Japanese Beetle Area. C. W. Stockwell, Riverton, N. J.

5. As Operated in the European Corn Borer Region. L. H. Worthley, Boston, Mass.

6. The Desirability of Discontinuing the Licensing and Bonding of Nurserymen. C. H. Hadley, Harrisburg, Penna.

7. Florida Quarantine:—America's Protection against Plant Pests of the American Tropics. L. R. Warner.

8. Results of Three Years' Experience in the control of Mosaic in Red Raspberries in Nurseries. A. G. Ruggles and J. D. Winter, St. Paul, Minn.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Wednesday Morning Session, December 29, 9:30

Report of the Secretary.

Report of the Executive Committee, by President Arthur Gibson.

Report of the Representative to the National Research Council, by T. J. Headlee, New Brunswick, N. J.

Report of the Committee on Policy, by P. J. Parrott, Geneva, N. Y.

Report of the Trustees of the Crop Protection Institute, by W. C. O'Kane, Durham, N. H.

Report of Scientific Trustee, Tropical Plant Research Foundation, by Herbert Osborn, Columbus, Ohio.

Report of the Representatives on the Council of the Union of American Biological Societies, by A. L. Quaintance, Washington, D. C.

Report of the Committee on Nomenclature, by Edith M. Patch, Orono, Maine.

Report of Editorial Board (A—Index to Economic Entomology, B—Biological Abstracts) by E. P. Felt, Albany, N. Y.

Report of the Committee on United States National Museum, by E. P. Felt, Albany, N. Y.

Report of Program Committee, by A. F. Burgess, Melrose Highlands, Mass.

Report of Committee Investigating Arsenical Residues on Fruit, by W. B. Herms, Berkeley, Calif.

Report of Committee for Holding 4th International Entomological Congress in America, by L. O. Howard, Washington, D. C.

Report of Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer, by George A. Dean, Manhattan, Kansas.

Report of Committee on Insect Pest Survey, by C. R. Crosby, Ithaca, N. Y.

Report of Delegate to the Pan Pacific Congress, by S. I. Kuwana, Yokohama, Japan.

Appointment of Committees.

Miscellaneous Business.

New Business.

Annual Address of the President, Arthur Gibson, Ottawa, Canada.

1. "International Entomology—Retrospective and Prospective."

Discussion of the Presidential Address.

Program

SECTION OF APICULTURE

J. I. HAMBLETON, *Chairman* G. M. BENTLEY, *Secretary*

Wednesday Afternoon Session, December 29, 1:30

Address by the Chairman, J. I. Hambleton, Washington, D. C.

READING OF PAPERS AND DISCUSSIONS

1. The Five Year Brood Record of a Single Queen. (15 min.) W. J. Nolan, Washington, D. C.
2. Waxworm Fumigation Experiments. (10 min.) F. B. Paddock, Ames, Iowa.
3. Federal Honey Grading Rules. . (15 min.) E. L. Sechrist, Washington, D. C.
4. Studies on the Evaporation of Nectar. (15 min.) O. W. Park, Ames, Iowa.
5. Effectiveness of the Area Clean up Method for American Foul Brood in Tennessee. (10 min.) W. L. Walling, Knoxville, Tenn.
6. The Present Status of Sterilization of American Foul Brood Combs. (15 min.) A. P. Sturtevant, Washington, D. C.
7. The Fertilization and Hibernation of Queen Bumblebees under Controlled Conditions. (5 min.) (Lantern.) T. H. Frison, Urbana, Ill.
8. Gaseous Chlorine as a Disinfectant for American Foulbrood. (10 min.) Ray Hutson, New Brunswick, N. J.
9. Certain Phases of Apicultural Research in the United States. (15 min.) J. I. Hambleton, Washington, D. C.
10. Outline of Program for 1927 Meeting—Open Discussion.

Report of Committees.

Selection of Officers.

Adjournment.

Wednesday Evening Session, December 29, 8:00

11. Some Things I saw and heard while visiting Beekeepers and their Societies in Europe in Summer of 1926. (30 min.) E. F. Phillips, Ithaca, N. Y.

Report of Committee on Translations Concerning Bee Diseases.

Program

Thursday Morning Session, December 30, 9:30

READING OF PAPERS

Miscellaneous

2. Insect Pests Newly Established in New York State. (10 min.) E. P. Felt, Albany, N. Y.

This is a general discussion of the distribution and economic status of a number of recent additions to New York insects.

3. The Status of Several Imported Insect Pests in Penna. (8 min.) (Lantern.) C. H. Hadley, Harrisburg, Pa.

Present status of Japanese beetle, corn borer, Mexican bean beetle, Oriental peach moth.

4. Some Highlights in the History of the Development of Entomology in California. (10 min.) E. O. Essig, Berkeley, Calif.

5. Some Problems in Economic Entomology. (10 min.) A. F. Burgess, Melrose Highlands, Mass.

Relations of different entomological activities are discussed and the need for more complete knowledge of economic pests.

6. Observations on *Euplectrus platyhypenae* How. (Chalcidae), a parasite of Noctuid larvae. (5 min.) (Lantern.) Roger C. Smith, Manhattan, Kans.

An account of the life history and habits of this external feeding parasite of the variegated cut worm and other noctuids.

7. The Artificial Culture and Dissemination of *Entomophthora sphaerosperma* Fres., a fungous parasite for the control of the European Apple Sucker, *Psyllia mali* Schmidb. (10 min.) Alan G. Dustan, Ottawa, Canada.

8. Charts and forms as Aids in Teaching Economic Entomology. (10 min.) (Lantern.) J. A. Manter, Storrs, Conn.

Discussion and illustration of some forms that have been developed at the Connecticut Agricultural College.

9. Water Binding Capacity of Colloids a Definite Factor in Winter Hardiness of Insects. (10 min.) (Lantern.) William Robinson, St. Paul, Minn.

Colloids present in insect tissues and bodyl iquids take up and bind water under a falling temperature. As water is withdrawn the body liquids become more concentrated and their freezing point greatly lowered.

10. Some Effects of Alternating Temperatures on the Growth and Metabolism of Cutworm Larvae. (10 min.) (Lantern.) William C. Cook, St. Paul, Minn.

11. Notes on Silkworm Nutrition. (5 min.) F. L. Campbell, New York, N. Y.

The Silkworm can extract some food for maintenance from cow's milk administered by mouth.

12. Dispersion of *Ccmpsilura concinnata* Meig., Beyond the Limits of the Gipsy Moth and the Brown-tail Moth Infestation. J. V. Schaffner, Jr., Melrose Highlands, Mass.

A brief account of the attempt made to obtain data, and some of the results secured, on the dispersion of this imported Tachinid parasite beyond the limits of infestation of the gipsy moth and the brown-tail moth.

Insects Affecting Greenhouse Crops

13. Observations on the Biology of a New Geranium Aphid (*Macrosiphum cornelli* Patch). (10 min.) Grace H. Griswold, Ithaca, N. Y.

The host plants of the aphid, number and length of instars, longevity of adults, parasites reared and control measures are discussed.

14. Further Observations on the Life History, Habits, and Control of the Narcissus Bulb Fly, *Merodon equestris*, with Data on the Effects of Carbon Disulphide Fumigation on Three Bulb Pests. (10 min.) (Lantern.) (Miss) B. M. Broadbent, Washington, D. C.

15. Observations on the Life History, Habits and Control of the Narcissus Bulb Fly, *Merodon equestris* Fab., in Oregon. (10 min.) Joseph Wilcox and Don C. Mote, Corvallis, Oregon.

16. Hot Water Bulb Sterilizers. (10 min.) (Lantern.) C. A. Weigel, Washington, D. C.

A brief discussion of the various types of sterilizers used to disinfect narcissus bulbs imported under special permit and in accordance with the Federal Horticultural Board requirements.

17. The Black Vine Weevil as a Pest in Greenhouses and Nurseries. (6 min.) (Lantern.) F. F. Smith, Willow Grove, Pa.

A progress report on the study of *Brachyrhinus* (*Otiorhynchus*) *sulcatus* with reference to its life history and distribution in Pennsylvania together with notes on control.

Insects Affecting Man and Animals

18. Further Studies with Sodium Fluoride for the Control of Cattle Lice. (6 min.) F. E. Guyton, Auburn, Ala.

Sodium fluoride gave good control for both chewing and sucking lice of cattle.

19. A Means of Control of the European Hen Flea (*Ceratophyllus gallinae* Shrank). (10 min.) M. A. Stewart, Rochester, N. Y.

This paper very briefly describes the control of the European hen flea (*Ceratophyllus gallinae* Shrank), by spraying the buildings with and dipping the birds in Phinotas Disinfectant.

INSECTS AFFECTING TRUCK CROPS

20. New Control Measures for the Squash Vine Borer. (10 min.) (Lantern.) C. R. Cleveland, Lafayette, Ind.

Experiments the past three summers have shown the possibility of securing satisfactory commercial control of this insect at practicable cost with several different stomach poison insecticides when given thorough, properly directed and timely application.

Program

Thursday Afternoon Session, December 30, 1:30

READING OF PAPERS

INSECTS AFFECTING THE HOUSEHOLD AND STORED PRODUCTS

21. The Black Carpet Beetle as a Pest of Raw Silk. (10 min.) Shonosuke Nakayama, Yokohama, Japan.

Discussion of an insect injurious to raw silk that is exported from Japan.

22. Argentine Ant Control Work in Mississippi. (10 min.) (Lantern.) R. W. Harned and M. R. Smith, A. & M. College, Miss.

A summary of the Argentine Ant control campaigns during the past seven years in Mississippi.

23. The Eradication of the Argentine Ant, *Iridomyrmex humilis*, at Fayette, Miss. (10 min.) (Lantern.) R. W. Harned and M. R. Smith, A. & M. College, Miss.

This is probably the first town infested with the Argentine Ant that has eradicated it. A brief report in regard to inspections made during the past three years is given.

INSECTS AFFECTING FRUIT

24. The Apple Maggot in Michigan. (10 min.) D. T. Ries, E. Lansing, Mich.

Some new facts concerning the life history and habits of apple maggot in Michigan.

25. Susceptibility of the Peach Cottony Scale to White and Lubricating Oil Emulsions. (10 min.) (Lantern.) P. J. Parrott, Geneva, N. Y.

The resistance of the scale to sulfide sprays has necessitated a modification of the standard spray schedule for peach orchards, provision being made for control of the pest by means of oil emulsions.

26. Metamorphosis and Reproduction in Apterous Forms of *Myzus persicae* Sulzer as Influenced by Temperature and Humidity. (10 min.) Alfred Weed, Madison, Wis.

27. Biological Factors in the Control of the Celery Tyer. (10 min.) E. D. Ball, B. L. Boyden, W. E. Stone and J. E. Reeves, Sanford, Fla.

The tyer does not thrive in normal summer or winter temperatures in Florida. The range of adaptation of the tyer and its parasites, warm winters as the cause of the recent outbreak and the importance of birds in control are discussed.

28. Two Species of Thrips Injurious to Apples in the Pacific Northwest. (5 min.) Leroy Childs, Hood River, Ore.

Character and extent of injury and some observations relative to control measures will be presented.

29. An Operation in Control of Codling Moth. (10 min.) T. J. Headlee, New Brunswick, N. J.

Over 1200 acres of bearing apple; over 300,000 bushel crop; averaged 74% picked fruit free from all codling moth injury; maximum per cent clean 97; late fruit in check orchard averaged 5 worm punctures per apple.

30. Types of Spray Coverage, Thoroughness of Spray Application and the Potency of Lead Arsenate in Codling Moth Control. (10 min.) (Lantern.) R. H. Smith, Riverside, Calif.

A summary of the results of a number of years' research in which original methods have been employed in orchard and laboratory work.

31. Trap Baits as a Supplementary Measure for Codling Moth Control. (5 min.) M. A. Yothers, Yakima, Wash.

32. Further Studies of Baits for Oriental Fruit Moth Control. (10 min.) S. W. Frost, Arendtsville, Pa.

The paper includes orchard tests of the bait-pail method of control and tests of various types of baits.

33. Baits More Attractive to the Oriental Peach Moth than "Blackstrap" Molasses. (10 min.) (Lantern.) Alvah Peterson, Riverton, N. J.

Some sugar possessing commercial products and fermenting fruits that attract oriental peach moths.

34. The Status of the Oriental Peach Moth in the South. (7 min.) O. I. Snapp, Fort Valley, Ga.

A brief discussion of the distribution, present infestation, and the future of the insect in the South, with a few remarks on the life history of the insect in that region.

35. The Hibernation Quarters of *Laspeyresia molesta* Busck. (10 min.) (Lantern.) L. A. Stearns, New Brunswick, N. J.

Data in respect to the relative number hibernating on the upper portions of the tree, on the tree trunk and on the ground as affecting the merits of spring cultivation as a control measure.

36. *Laspeyresia molesta* as an Apple Pest. (10 min.) (Lantern.) E. N. Cory and H. S. McConnell, College Park, Md.

The extent of injury to apples, types of feeding, egg laying habits and late egg parasitism.

37. Notes on the Occurrence of *Luperodes thorasicus* as an Insect Pest of Fruit Trees. (5 min.) (Lantern.) T. L. Guyton, Harrisburg, Pa.

This paper also includes notes on the dispersal of two other insects common in Pennsylvania.

38. Experiments in Control of the Rose-chafer, *Macrodactylus subspinosus* Fab., in Vineyards. (5 min.) G. A. Runner, Sandusky, Ohio, and J. R. Eyer, North East, Pa.

39. Some problems Connected with Curculio Control on Apples in Connecticut. (10 min.) (Lantern.) Philip Garman, New Haven, Conn.

Results of field experiments and observations showing different phases of control, comparisons of seven-day application with other schedules from which this spray is omitted. Habits bearing on control.

40. The History and Development of Strawberry Root Weevil Control. (10 min.) W. Downes, Victoria, B. C., Canada.

Program

Friday Morning Session, December 31, 9:30

READING OF PAPERS

Insecticides and Appliances

41. Paradichlorobenzene against the Black Peach Aphis, *Anuraphis persicae-niger* Smith. (5 min.) (Lantern.) C. R. Cutright, Wooster, Ohio.

The results of four years field experimentation show that this material can be used safely and effectively.

42. Tests of Recently Developed Insecticides for the Control of the Grape Leafhopper and Oriental Fruit Moth. (10 min.) (Lantern.) J. R. Eyer, North East, Pa.

43. Arsenic Content of Sprayed Apples. (10 min.) (Lantern.) Albert Hartzell and F. Wilcoxson, Yonkers, N. Y.

Results of analyses of apples sprayed according to a definite schedule during the

season of 1926, with the discussion of the probability of a sample falling above the British Standard of 1/100 grain of arsenic per pound.

44. The Relative Value of Different Insecticide Treatments for Codling Moth Control. (10 min.) W. S. Regan, Yakima, Wash.

45. The Relation of Leaf and Twig Growth of Two Varieties of Apples to the Quantity and Adherence of Lead Arsenate Throughout the Spraying Season. (8 min.) (Lantern.) C. C. Hamilton, New Brunswick, N. J.

46. Adapting Fumigation Procedures to Industrial Needs. (10 min.) V. I. Safro, Los Angeles, Calif.

Discussing some basic principles of industrial fumigation including the dosage range, air circulation during fumigation, penetration, retention, and correcting some former ideas on absorption of HCN by foodstuffs.

47. Cyanide Dust Fumigation. (10 min.) (Lantern.) H. J. Quayle, Riverside, Calif.

Describing original experiments in cyanide dust fumigation and discussion of present status particuarly as applied to citrus fumigation.

48. Calcium Cyanide as a Control for Cranberry Root Worm on Cultivated Blueberry. (10 min.) B. F. Driggers, Pemberton, N. J.

49. Cyanogas Calcium Cyanide for House Fly Fumigation in Certain Types of Buildings. (10 min.) (Lantern.) C. O. Eddy, Clemson College, S. C.

Hydrocyanic acid gas derived from Cyanogas Calcium Cyanide has been a cheap and effective toxin for house flies in barns, laboratories, stores and dwellngs in experiments conducted by the writer during the past season.

50. Control of Cotton Hopper by Calcium-sulfo-cyanide. (10 min.) H. G. Good, Auburn, Ala.

Calcium sulfo-cyanide has been very effective in the control of the cotton-hopper and no burning of foliage resulted.

51. A Modified Electro-Gutzeit Apparatus for the Quantitative Estimation of Minute Amounts of Arsenic in Insects. (5 min.) (Lantern.) D. E. Fink, Philadelphia, Pa.

52. Is the Glutathione Content of Insects the Arsenic Receptor? (5 min.) (Lantern.) D. E. Fink, Philadelphia, Pa.

This paper deals with the quantitative estimation of glutathione in normal insects and those after treatment with arsenicals of varying dilutions.

53. The Argentine Ant Formula, Why does it fail? (5 min.) A. C. Burrill, Jefferson City, Mo.

54. Modified Types of Spraying Machines. (10 min.) (Lantern.) R. W. Leiby, Raleigh, N. C.

Heat expansion principle of producing a mist from a liquid.

INSECTS AFFECTING FOREST AND SHADE TREES

55. The Genus *Ips* on the Stanford Campus. (10 min.) R. W. Doane, Stanford University, Calif.

Twenty years ago *Ips plastographus* was the only species of *Ips* to be found in this vicinity. Ten years ago *I. radiatae* was more abundant than *I. plastographus*. Today both of these species have been supplanted by *I. confusus*.

56. Airplane Dusting Experiment for Gipsy Moth Control. (10 min.) (Lantern.) D. F. Barnes and S. F. Potts, Melrose Highlands, Mass.

Discusses the infestation treated, control secured, poison distribution, and relation of topographical and meteorological factors to results obtained.

57. The Control of the Hemlock Spanworm by Airplane Dusting. (10 min.) (Lantern.) S. B. Fracker and A. A. Granovsky, Madison, Wis.

Calcium arsenate at the rate of twenty pounds to the acre, dusted over a mixed rugged forest was successful in killing the larvae of *Ellopia fiscellaria* attacking hemlock and balsam.

Program

Friday Afternoon Session, December 31, 1:30

READING OF PAPERS

INSECTS AFFECTING FOREST AND SHADE TREES (*Continued*)

58. A Method of Poisoning the Locust Borer, *Cyllene robiniae*. (8 min.) W. P. Flint and C. C. Compton, Urbana, Ill.

59. *Ellopoa athasaria*, A Looper Attacking Hemlock. (10 min.) (Lantern.) J. S. Houser, Wooster, Ohio.

Record of an outbreak in eastern Ohio.

60. Some Important Economic Insects of Central Europe. (10 min.) R. T. Webber, Melrose Highlands, Mass.

An account of some observations made by the writer while engaged in foreign investigation of the Gipsy Moth.

61. Some of the Important Forest Insects of Western Europe. (10 min.) S. M. Dohanian, Melrose Highlands, Mass.

A brief discussion of the major insect pests affecting the forests of France, Italy, Spain and Portugal.

62. Termites Modify Building Codes. (10 min.) (Lantern.) T. E. Snyder, Washington , D. C.

Summary of termite damage to buildings in the United States, types of termite injury, slight modifications of building codes to prevent termite damage, work of the National Wood Utilization Commission on the buildings project.

Insects Affecting Cereal, Forage and Field Crops

63. The Green Bug in Minnesota. (10 min.) (Lantern.) A. G. Ruggles, St. Paul, Minn.

Some theories are presented to show the origin of the infestation.

64. Observations on a New and Important Cotton Pest. (5 min.) (Lantern.) A. W. Morrill, Los Angeles, Calif.

A species of Bucculatrix (*B. gossypiella* n. sp.) the adult of which, so far as studied appears identical with *B. thurberiella* Busck, occurs in Sonora and Sinaloa, Mexico.

65. A Study of the Cotton Hopper, *Psallus seriatus* Reut. (Miridae) with Especial Reference to its Effect on Plant Tissue. (10 min.) (Lantern.) R. H. Painter, Manhattan, Kans.

66. Three Years of Boll Weevil Control on One-Twentieth Acre Plots, with Various Rates of Fertilizer. (10 min.) (Lantern.) J. M. Robinson, Auburn, Ala.

One series of plots was dusted with calcium arsenate; the other series was not dusted. The total amount of seed cotton per acre indicates the value of dusting when boll weevils are present.

67. Winter Survival of the Cotton Boll Weevil at Florence, South Carolina. (10 min.) F. A. Fenton, Florence, S. C.

A study of three years records on hibernation and spring emergence of the boll weevil at Florence, S. C.

68. Ecological Habitats of the European Corn Borer. (10 min.) (Lantern.) L. L. Huber and C. R. Neiswander, Wooster, Ohio.

This paper deals with the correlation between the actual degree of infestation by the European corn borer and certain vegetative types.

69. The Status of the European Corn Borer in Canada (1926). (10 min.) L. S. McLaine and H. G. Crawford, Ottawa, Canada.

This paper shows the natural spread of this pest during the past season and the increase in the intensity of infestation in certain areas.

70. The European Corn Borer in Weeds and Truck Crops in Ohio. (10 min.) C. R. Neiswander and L. L. Huber, Wooster, Ohio.

This paper is a discussion of the natural and artificial infestation of weeds and truck crops in Ohio.

71. Airplane Dusting of Sugar Cane. (10 min.) (Lantern.) W. E. Hinds and Herbert Spencer, Baton Rouge, La.

In 1926 thirteen hundred acres of sugar cane in Louisiana were dusted experimentally with airplanes for control of the sugar cane borer, *Diatraea saccharalis*. The applications and the results are discussed in this paper.

72. Curly-Top of Sugar Beets in South Dakota. (5 min.) H. H. P. Severin, Berkeley, Calif. and H. C. Severin, Brookings, S. D.

73. Some Leaf Hoppers of Economic Importance in North Carolina. (5 min.) (Lantern.) Z. P. Metcalf, Raleigh, N. C.

Notes on the Bean Leaf Hopper and other species injurious to cotton, soy beans, peanuts and other crops.

74. Preliminary Notes on the Depth of Hibernation of Wireworms. (10 min.) J. W. McColloch, W. P. Hayes and H. L. Bryson, Manhattan, Kans.

Preliminary studies indicate that wireworms in Kansas do not go deeply to hibernate and are often found in midwinter above the plow line while in no instance were they found deeper than 36 inches, with the average depth about 7 inches.

Program

Saturday Morning Session, January 1, 1927, 9:30

READING OF PAPERS

Japanese Beetle and Asiatic Beetle

75. Organization of a Co-operative Campaign against the Asiatic Beetle. (10 min.) W. E. Britton, New Haven, Conn.

How funds were received from four sources and the work conducted.

76. The Asiatic Beetle (*Anomala orientalis* Waterh.) (10 min.) (Lantern.) R. B. Friend, New Haven, Conn.

The life history and habits of this insect as observed in Connecticut in 1926.

77. Soil Treatment and Scouting for the Control of the Asiatic Beetle. (10 min.) (Lantern.) J. Peter Johnson, New Haven, Conn.

A resume of the quarantine, scouting and control work for the Asiatic beetle during 1926.

78. Some Problems in the Organization of Entomological Projects. (10 min.) (Lantern.) Loren B. Smith, Riverton, N. J.

Good and bad features of organization and planning are pointed out. The organization of work on the Japanese Beetle project is cited and briefly discussed in reference to the general problem.

79. A New Phototropic Apparatus. (5 min.) (Lantern.) E. Avery Richmond, Riverton, N. J.

An apparatus, recently devised for use in conection with certain phototropic experiments on the Japanese beetle relative to the value of color and light.

80. The Present Status of the Work on the Parasites of *Popillia japonica* Newman. (10 min.) (Lantern.) J. L. King, H. W. Allen and H. C. Hallock, Riverton, N. J.

This article is a summary of the progress on the introduction of parasites of *Popillia iaponica* covering such points as parasite importation, insectary manipulation, colonization and recovery.

81. A Method of Grub-Proofing Turf. (10 min.) (Lantern.) B. R. Leach and J. W. Lipp, Riverton, N. J.

The use of arsenate of lead mixed with the soil to a depth of 3 or 4 inches before seeding, or used in the top dressing on turf already established.

82. Further Information on a Contact Spray for Control of the Japanese Beetle. (5 min.) E. R. Van Leeuwen and P. A. van der Meulen, Riverton, N. J.

The purpose of this paper is to record the improvement made in the sodium oleate-oleoresin of pyrethrum spray for the control of the Japanese beetle by the addition of sodium silicate.

83. Fluosilicate as Stomach Poisons for the Japanese Beetle. (10 min.) Walter E. Fleming, Riverton, N. J.

Extensive tests were made during the summers of 1925 and 1926 to determine the relative value of acid lead arsenate and the fluosilicates of barium, calcium, sodium and potassium as stomach poisons for the adult Japanese beetle.

84. The Present Range of the Japanese Beetle, *Popillia japonica* Newm. in America. (10 min.) (Lantern.) Henry Fox, Riverton, N. J.

An attempt to discriminate between the territory occupied as a result of natura spread and that colonized through artificial introduction. A consideration of the probable factors influencing the direction and rate of dispersal.

Final Business

Report of Committee on Resolutions.
Report of Committee on Membership.
Reports of other committees.
Nomination of Journal officers by advisory committee.
Report of Committee on Nominations.
Election of Officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

Arthur Gibson, *President*,
Ottawa, Canada

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Melrose Highlands, Mass.

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